R E P O R T   R E S U M E S

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COMPUTER-AIDED DRAFTING AND DESIGN, A THREE-WEEK SUMMER INSTITUTE TRAINING PROGRAM (MIAMI-DADE JUNIOR COLLEGE, MIAMI, FLORIDA, JULY 10, 1967 - JULY 28, 1967). FINAL REPORT.

BY- MORPHONIOS, ALEX G.
MIAMI-DADE JUNIOR COLL., FLA.

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DESCRIPTORS- *SUMMER INSTITUTES, *COMPUTER ASSISTED INSTRUCTION, COMPUTER PROGRAMS, *DRAFTING, *ENGINEERING DRAWING, PROGRAMING, TEACHER EDUCATION, *INSTRUCTIONAL MATERIALS,

THIRTY-SIX INSTRUCTORS, SUPERVISORS, AND DEPARTMENT CHAIRMEN IN AREAS OF DRAFTING, ENGINEERING, MANUFACTURING, AND COMPUTER TECHNOLOGY AT JUNIOR COLLEGES, TECHNICAL, AND AREA VOCATIONAL SCHOOLS IN 20 STATES ATTENDED A 3-WEEK SUMMER INSTITUTE TRAINING PROGRAM ON COMPUTER-AIDED DRAFTING AND DESIGN. EXPERIENCE IN PROGRAMING THE IBM SYSTEM 1620 WITH AN ON-LINE 1627 PLOTTER UTILIZING THE DRAFTING LANGUAGE WAS PROVIDED. THREE LANGUAGES WERE USED--THE DRAFTING LANGUAGE, COGO (COORDINATE GEOMETRY) USED IN CIVIL ENGINEERING, AND THE LANGUAGE FOR NUMERICAL CONTROL. THIS PUBLICATION CONTAINS (1) THE REFERENCE MATERIALS AND PROGRAMING EXERCISES USED IN THE INSTITUTE, INCLUDING ILLUSTRATIONS DRAWN AND DESIGNED WITH THE ON-LINE 1627 PLOTTER, (2) CODE INSTRUCTIONS FOR PROGRAMING THE PRATT-WHITNEY TAPE-O-MATIC DRILLING MACHINE, (3) DETAILED INSTRUCTIONS FOR USE OF THE AUTOSPOT (AUTOMATIC SYSTEM FOR POSITIONING TOOLS) PROGRAM SYSTEM, AND (4) PLOTTING ROUTINES FOR THE COGO SYSTEM WHICH ALLOW THE USER TO DISPLAY GRAPHICALLY ON AN IBM 1627 CALCOMP PLOTTER THE RESULTS OF THE COORDINATE COMPUTATION, WITH OR WITHOUT ANNOTATION, AND WITH OR WITHOUT CONNECTING STRAIGHT OR CIRCULAR LINES. (PS)

ED016859

FINAL REPORT.

1967 SUMMER INSTITUTE

MIAMI-DADE JUNIOR COLLEGE

4482

~~VT004597~~

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MIAMI-DADE JUNIOR COLLEGE MIAMI, FLORIDA

north campus 11380 n. w. 27th avenue
miami, florida 33167

Division of Technical,
Vocational, and
Semiprofessional Studies
Telephone: 685-4301-2-3

"A Three-Week Summer Institute Training Program--
Computer-Aided Drafting and Design"

Final Report - Summary

A. Grant Number: OEG 2-7-070435-3135 - United States Office of Education, Department of Health, Education, and Welfare

B. Project Number: 7-0435

C. Investigator: Alex G. Morphonios - Associate Professor, Division of Technical, Vocational and Semiprofessional Studies

D. Institution: Miami-Dade Junior College, Miami, Florida

E. Duration: July 10, 1967 - July 28, 1967

F. Objectives:

1. To retrain teachers who have a minimum of two years teaching experience in the fields of drafting, mechanical, manufacturing, and electronic data processing technologies for teaching of the newly emerging subject of Computer-Aided Drafting and Design.

2. To assist with the development of knowledge and skill essential for teaching and/or evaluation of courses in the subject area.

3. To further develop suggested course material including course content, references, visual and other instructional aids suitable for use as patterns and guidelines for future programs.

4. To assist in meeting the urgent national need for teachers of specialized subject matter courses in preparatory drafting and related curriculums.

5. To instruct teachers in the techniques and applications of Computer-Aided Drafting as used by industry.

6. To teach the drafting system programming language to the instructor so that they may teach automated drafting to their students and all others who wish to learn.

G. <u>Participants</u>:

1. Selection

   a. One hundred and twenty (120) letters were received from thirty-two (32) States, Washington, D. C. and Puerto Rico expressing an interest in attending the Institute.

   b. Letters, applications and brochures were sent to all interested parties. Applications were returned from sixty-one (61) applicants. These were received from twenty-four (24) States.

   c. Considerable effort was placed on design of the application and its content. The committee made its selection on the basis of need to know; how information would be utilized; area of interest; experience and other considerations.

   d. Each participant was notified of his selection by letter and then all were asked to reconfirm on June 16th. Ten (10) participants who cancelled were replaced by names from a priority list. Only one of the final group was a "no show."

2: General Information

   Housing information, maps of Dade County and a brochure of scheduled events for Greater Miami were forwarded to each participant.

H. <u>Programs</u>:

1. Program Goals

   A course was devised to give the participant an introduction to data processing and elementary knowledge of the IBM System 1620. Emphasis was placed on the drafting language for the 1627 plotter. After completing the course, the participant will have the knowledge and experience to write programs, operate the IBM System 1620 and 1627 plotter, and teach others the course material. He will also have experience using COGO and an elementary knowledge of numerical control for point-to-point processing.

2. Major Topics

   a. Introduction and Orientation.

   b. Introduction to Data Processing.

   c. Operating the IBM System 1620, 1627 Plotter, 026 Key Punch.

   d. Complete course in the 1620 Drafting Language.

   e. Experience in writing programs.

   f. Use the System 1620 for executing programs using the 1627 Plotter.

   g. Introduction to Numerical Control.

   h. Introduction to Coordinate Geometry Language (COGO).

   i. Experience writing programs using COGO.

   j. Use of the System 1620 and 1627 Plotter for execution of COGO programs.

   k. Introduction to FORTRAN and the plotting subroutines for the 1627 Plotter.

   l. Industrial Presentations and Tours.

3. Scheduling

   a. The problems of handling thirty-six (36) participants with the limitation of any computer laboratory facility offered a challenge. Although there appeared to be no perfect solution, the following schedule was the method that was used to resolve the problem.

   b. Classes were begun at 8:00 a.m. each workday and they were concluded at 4:30 p.m. with one hour reserved for lunch. The thirty-six (36) participants were divided into group A and group B. Each group was divided into six teams. Group A and B attended joint lectures three hours each day. Each group spent two hours in the computer laboratory and a half hour at the close of each day was scheduled as an open laboratory. When one group was in the laboratory for their two hour period, the other group was in a classroom writing programs and analyzing problems.

c. After the first morning, which was devoted to registration, introductions, and orientation, the above schedule was altered only to allow time for guest speakers and field trips.

4. Guest Speakers

a. Mr. Charles Smith, IBM Systems Engineer from IBM's Miami Office, presentation "AIDS PROJECT." This project is a joint effort of Eastern Airlines and IBM in analysis of airborne engine data for preventative maintenance. A plotter is used for presentation of data.

b. Mr. Arthur Lego, Engineering Data Management, The Martin Company, Orlando, Florida. Presentation describing the utilization of their Plotter for such tasks as drawing machine tool parts, printed circuits, electronic schematics, logic circuits, etc.

c. Mr. Neil Michelson, Special Representative, IBM Corporation, Poughkeepsie, N. Y. Presentation about present and future plotter applications.

d. Mr. James Pirkle and Mr. Robert Raynolds, Data Product Division, Stromberg-Carlson Corporation. Presentation on Micromation as applied to Graphics.

e. Mr. J. Frederick Smith, Sales Engineer, Compudyne Corporation, Hatboro, Pennsylvania. Presentation "An approach to N/C."

f. Mr. Irving Thornton, Jr., District Sales Engineer, CALCOMP, St. Petersburg, Florida. Presentation, "Plotter Applications and Computer Compatability."

5. Field Trips

   a. Milgo Electronic Corporation, Miami, Florida. Manufacturer of analogue plotters and various types of computers.

   b. Automated Building Components, Miami. ABC used a computer and plotter to solve and graphically display building truss problems.

   c. University of Miami, Institute of Marine Science, Virginia Key, Florida. They utilize an off-line plotter for many different oceanographic applications.

6. President's Luncheon

   This activity on the last day of the Institute was planned as the high point of the three weeks. A talk on the educational opportunities for the disadvantaged was scheduled. This was to be followed by a round-table expression of thoughts regarding the Institute. The luncheon was highlighted with the presentation of certificates for successfully completing the Institute.

7. Reference Material

   In addition to those companies who had representatives give presentations, the following organizations were of assistance to the Institute: The Boeing Company, Gerber Scientific Company, Pratt and Whitney, and the Department of the Air Force.

I. Results:

1. All the objectives of the Institute were achieved and with a high degree of success.

2. Emphasis was placed on obtaining from the applicants background information; need to know; how knowledge would be utilized; and other data which allowed the selection of an excellent group of participants. The participants were motivated by their thirst for knowledge and determination to ride with the vehicle of automation. They were also enthused with the opportunity to pioneer in a new field for which they were well equipped.

3. Most of the participants had little or no knowledge of the field of computer technology; however, in a short period of time the wall of fear encompassing

Electronic Data Processing had been shattered by the Institute. The participants now have an understanding of the fundamentals of EDP and the experience of programming in the field of computer-aided drafting and design.

4. Each participant was presented a large notebook which contained an hourly schedule, course outline, exercises, sketches, manuals, and other data. When the Institute was completed, the notebook (about three inches thick) contained plates and programs for the twenty-seven exercises; demonstration plates, write-ups, manufacturer's brochures and data sheets; reference articles and other information.

5. Detailed orientation of the participants established a firm foundation for the direction, methods, and scope of the Institute. Each participant understood the goals that they were expected to obtain and the challenge that it offered. They were told (lectures), shown (demonstrations), and given the opportunity to write and operate programs on the computer and plotter. This approach assisted them in securing an appreciation and understanding of programming in the area of computer-aided drafting and design.

6. The guest speakers contributions to the Institute were of significant value. The subject matter presented included equipment, systems, (past, present and future), commercial and military applications, equipment compatability and other areas of interest. Most of the presentations included visual aids. Question and answer sessions indicated the keen interest of the participants.

J. Conclusions:

1. An analysis of this Summer Institute by the participants, the Institute staff and other interested parties, agree that this was a very successful project. This appraisal is supported by the fact that many of the participants propose to establish new courses in computer aided drafting and design. All are expected to use this knowledge and material in existing classroom activities.

2. Adhering to the concept of eliminating as much redundancy as practical and conducting an extensive preparation of the course material and presentations, enabled the participants to comprehend lectures, the experience of programming and the text which is worthy of a two semester course in computer-aided drafting and design.

3. It is recommended that Institutes making extensive use of a plotter be limited to twenty to twenty-four participants. This would allow each participant a greater amount of time with the computer and plotter. An off-line plotter would help to increase the efficiency. However, under any circumstances, thirty-six participants are too many.

4. The tremendous dedication and knowhow of a very small staff has made the proposed Institute a reality. Special cognizance is made of the technical competency and teaching technique of the principle lecturer who has contributed so much to the success of this Institute.

Alex G. Morphonios

Alex G. Morphonios - Associate Professor,
Division of Technical, Vocational and
Semiprofessional Studies.

MIAMI-DADE JUNIOR COLLEGE MIAMI, FLORIDA

north campus 11380 n. w. 27th avenue
miami, florida 33167

...on of Technical,
...cational, and
...fessional Studies
...ne: 685-4301-2-3

Dear Sir:

Thank you for your interest in the "Three Week Summer Institute Training Program--Computer-Aided Drafting and Design."

The contract with the United States Office of Education has just been signed and returned to Washington, D. C.

The Institute will present the participant an introduction to data processing and an elementary knowledge of the IBM System 1620. Emphasis will be placed on the Drafting Language for the 1627 plotter. After completing this Institute, the participant will have the knowledge and experience to write programs, operate the IBM System 1620 and 1627 plotter and teach others the course material. He will also have experience using COGO and an elementary knowledge of numerical control for point-to-point processing.

Funding will be limited to thirty-six participants. Stipend will cover a period of three weeks at a rate of seventy-five dollars per week. Travel allowance will be based upon a round trip tax exempt air tourist fare from your institution to Miami or travel by automobile at a rate of seven and one-half cents per mile. Reimbursement of actual travel is assured up to one hundred and forty-eight dollars. Extra funds are expected to become available because of some participants traveling short distances and these funds will be reallocated to the participants traveling greater distances.

Brochures with additional details are expected to be released within one week; however, you are requested to complete the enclosed application and return it immediately.

Sincerely,

Alex G. Morphonios, Chairman
Instrumentation and Automation

AM/mg

...campus 11011 s. w. 104th street
miami, florida 33156

miami beach center 1410 drexel avenue
miami beach, florida 33139

MIAMI-DADE JUNIOR COLLEGE

1967 SUMMER INSTITUTE

FOR

COMPUTER AIDED DRAFTING AND DESIGN

APPLICATION

1. NAME ______________________________
(last) (first) (middle)

2. HOME ADDRESS ______________________________
(no. and street)

______________ ______________ ______________
(City) (State) (Zip-Code)

3. INSTITUTE ______________ TYPE OF INSTITUTE ______

4. OFFICE ADDRESS ______________________________
(no. and street)

______________ ______________ ______________
(City) (State) (Zip-Code)

5. HOME TELEPHONE ______________ OFFICE TELEPHONE ______

6. U. S. CITIZEN Yes ___ No ___ SOCIAL SECURITY NO. ______

7. AGE ________ MARITAL STATUS ________ NO. OF CHILDREN ____

8. PRESENT POSITION ______________ DEPARTMENT ______

9. PROFESSIONAL DEGREES ______________ MAJORS ______

10. Have you had any experience in Drafting and/or Design? ______

11. Do you have any experience in Programming? ______
(This is not a requirement)

12. Does your school offer an Electronic Data Processing program? ______

13. Does your school have a computer plotter? ______

14. Does your school plan to offer an Electronic Data Processing program? ____

15. Why do you wish to attend and who will benefit other than yourself?
(Write answer on back side of this sheet)

Applicant's Signature ______________________________

I recommend that the applicant attend this Summer Institute

(Immediate Supervisor preferred) Signed ______________________

Position ______________________

1. NAME ____
(last) (first) (middle)

2. HOME ADDRESS ______________________________________
(no. and street)

______________ ______________ ______________
(City) (State) (Zip-Code)

3. INSTITUTE ______________ TYPE OF INSTITUTE ______

4. OFFICE ADDRESS ____________________________________
(no. and street)

______________ ______________ ______________
(City) (State) (Zip-Code)

5. HOME TELEPHONE ______________ OFFICE TELEPHONE ______

6. U. S. CITIZEN Yes ___ No ___ SOCIAL SECURITY NO. ______

7. AGE ______ MARITAL STATUS ______ NO. OF CHILDREN ______

8. PRESENT POSITION ______________ DEPARTMENT ______

9. PROFESSIONAL DEGREES ______________ MAJORS ______

10. Have you had any experience in Drafting and/or Design? ______

11. Do you have any experience in Programming? ______
(This is not a requirement)

12. Does your school offer an Electronic Data Processing program? ______

13. Does your school have a computer plotter? ______

14. Does your school plan to offer an Electronic Data Processing program? ______

15. Why do you wish to attend and who will benefit other than yourself?
(Write answer on back side of this sheet)

Applicant's Signature ______________________________

I recommend that the applicant attend this Summer Institute

(Immediate Supervisor preferred) Signed ______________________

Position ______________________

Please mail this completed application to:

Alex G. Morphonios, Chairman
Department of Instrumentation and Automation
Miami-Dade Junior College
11380 N. W. 27th Avenue
Miami, Florida 33167

PROGRAM

This course gives the participant an introduction to data processing and elementary knowledge of the IBM System 1620. Emphasis is on the drafting language for the 1627 plotter. After completing this course the participant will have the knowledge and experience to write programs, operate the IBM System 1620 and 1627 plotter, and teach others the course material. He will also have experience using COGO and an elementary knowledge of numerical control for point-to-point processing.

MAJOR TOPICS

Introduction and Orientation.
Introduction to Data Processing.
Operating the IBM System 1620, 1627 Plotter, 026 Key Punch.
Complete course in the 1620 Drafting Language.
Experience in writing programs.
Use the System 1620 for executing programs using the 1627 Plotter.
Introduction to Numerical Control.
Introduction to Coordinate Geometry Language (COGO I-D).
Experience writing programs using COGO.
Use of the System 1620 and 1627 Plotter for execution of COGO programs.
Introduction to FORTRAN II-D and the plotting subroutines for the 1627 Plotter.
Industrial Presentations and Tours.

AM-5/7/67

Printed by DUPLICATING DEPARTMENT MIAMI-DADE JUNIOR COLLEGE

STIPENDS AND ALLOWANCES

Participants will receive a stipend of $225 for the three week period. Travel allowance will be based upon round trip tax exempt air tourist fare from your institution to Miami or travel by automobile at a rate of 7.5 cents per mile. Reimbursement of actual travel cost (as noted above) is assured up to $148.58. Extra funds are expected to become available because of some participants traveling short distances and these will be reallocated to those participants who are traveling greater distances.

HOUSING

Sufficient housing is available at Summer rates in Miami and Miami Beach for participant and his family. Each person will be responsible for his own housing arrangements.

ADMISSION

Complete application and send it to:
Summer Institute 1967
Alex G. Morphonios, Chairman
Department of Instrumentation and Automation
Miami-Dade Junior College
11380 N. W. 27th Avenue
Miami, Florida 33167

This Summer Institute is receiving the support of a Grant Award No. 2-7-070435-3135 from the United States Office of Education.

Summer Institute for Computer-Aided Drafting and Design

MIAMI-DADE JUNIOR COLLEGE 1960 SCIENTIA EST POTENTIA

Miami, Florida

JULY 10-28, 1967

SUPPORTED BY

UNITED STATES OFFICE OF EDUCATION

OBJECTIVES

To provide a basis for the understanding programming and utilization of one of industry's newest developments in automation--Computer-Aided Drafting and Design.

To strive toward technical excellence in programming of the IBM System 1620 with an on-line 1627 Plotter utilizing the drafting language.

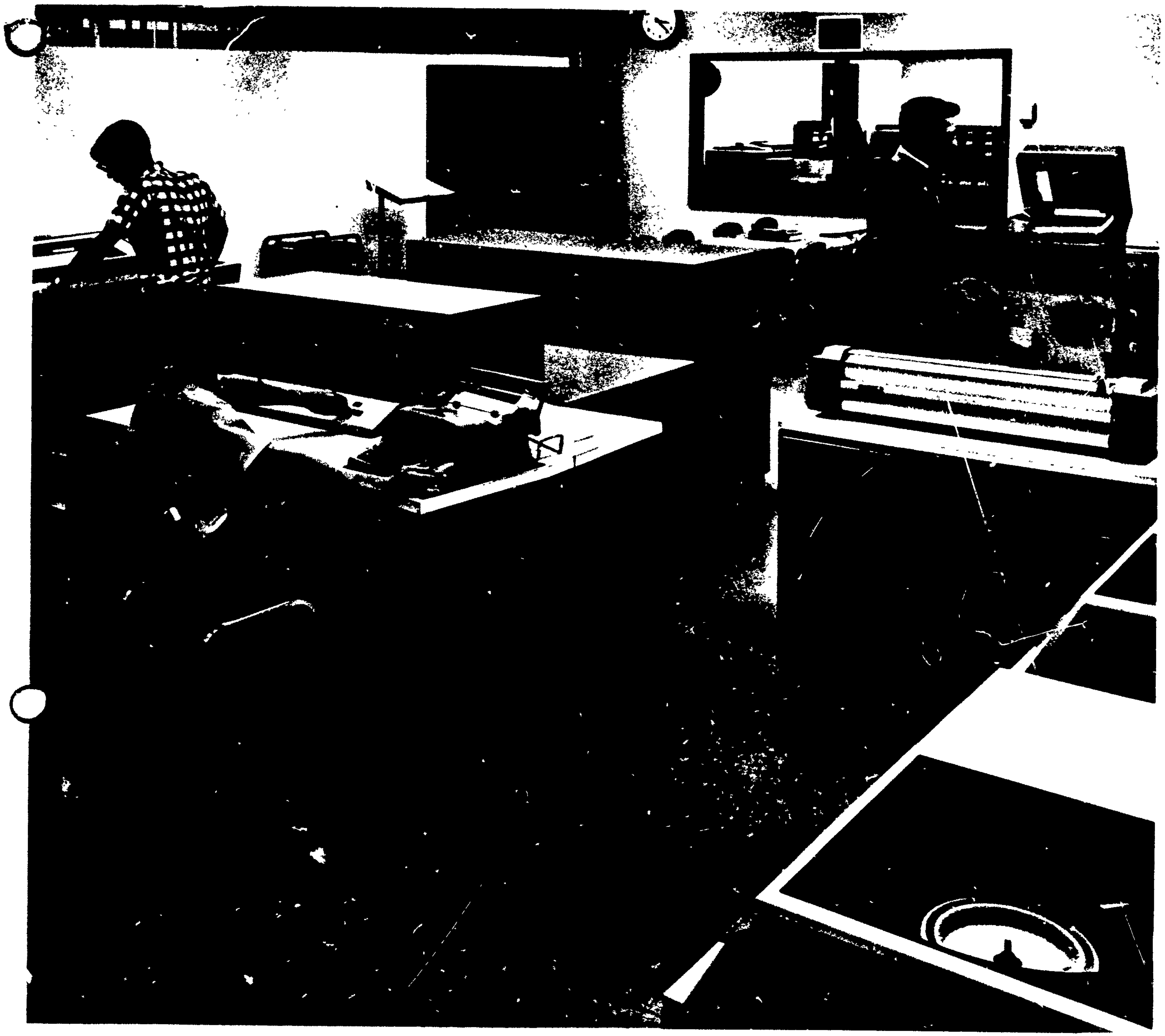
To present a complete course package of soft ware in addition to classroom lectures and laboratory experiences which will provide the participant with the take-home knowledge necessary to teach a course on computer-aided drafting and design.

ELIGIBILITY

No previous knowledge of computers is necessary.
The institute will be open to thirty-six participants from Junior Colleges, Technical and Area Vocational Schools.

Teachers active in the areas of Drafting, Engineering, Manufacturing, and Computer Technology.

A committee will select participants on the basis of need to know; how information will be utilized; area of interest; experience and other considerations.



MIAMI-DADE JUNIOR COLLEGE MIAMI, FLORIDA

north campus 11380 n. w. 27th avenue
miami, florida 33167

Dear Sir:

We are pleased to notify you of your acceptance as a participant in the Summer Institute for Computer-Aided Drafting and Design which will be held at Miami-Dade Junior College from July 10th through the 28th.

If you have a drafting plate that you would like to reproduce on the plotter, please bring it with you.

Should you be unable to attend this Institute, please advise the writer immediately in order that an alternate may attend.

Sincerely,

Alex G. Morphonios, Chairman
Instrumentation & Automation

AM/mg

south campus 11011 s. w. 104th street
miami, florida 33156

miami beach center 1410 drexel avenue
miami beach, florida 33139

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north campus 11380 n. w. 27th avenue
miami, florida 33167

ision of Technical,
Vocational, and
professional Studies
phone: 685-4301-2-3

June 16, 1967

Dear Sir:

Please confirm your participation in the Summer Institute for Computer-Aided Drafting and Design that will be held at Miami-Dade Junior College from July 10th through the 28th.

A map of the greater Miami Area and some general housing information will be forwarded to you next week.

Sincerely,

Alex G. Morphonios

Alex G. Morphonios, Chairman
Department of Instrumentation
and Automation

jw

PLEASE COMPLETE AND RETURN IMMEDIATELY:

I,________________________________, (DO______DO NOT______)

wish to confirm my status as a participant.

south campus 11011 s. w. 104th street
miami, florida 33156

miami beach center 1410 drexel avenue
miami beach, florida 33139

APPLICATIONS AND STATUS

STATE & NAMES	APPROVED	CONFIRMED	CANCELLED	REMARKS
ALABAMA				
Skinner	X	X		
CALIFORNIA				
Auerbach	X	X		Use home address
Ayers				
Deal	X		X	
Harper				
James	X	X		
Gerevas	X	X		
Gonzalez	X	X		Use home address
McVicar	X	X		
Peck	X	X		
CONNECTICUT				
Bradshaw	X	X		
Caruso				
FLORIDA				
Green	X	X		
Nelson	X		X	
Myers	X	X		No show
Feldman	X	X		
Sits	X	X		
GEORGIA				
Stewart	X	X		
ILLINOIS				
Marks	X	X		
Zolper				
IOWA				
Druart	X	X		
Hebbeln				
MAINE				
Libby	X	X		
Vassar	X	X		
MASSACHUSETTS				
Levesque	X	X		
MINNESOTA				
Steen	X	X		

MISSISSIPPI	APPROVED	CONFIRMED	CANCELLED	REMARKS
Simmons	X		X	
NEW MEXICO				
Aller	X		X	
NEW YORK				
Cohen				
Gressman	X	X		
Mueller	X	X		
Miccio	X		X	
Pappas				
Steggen	X		X	
OHIO				
Isbell	X	X		
OKLAHOMA				
Rutledge	X	X		
OREGON				
Latham	X		X	
PENNSYLVANIA				
Graves	X	X		
McQuay	X	X		
Zimmerman				
RHODE ISLAND				
Amend	X	X		
Anderson	X	X		
Birong				
D'Ambra				
Desanto				
McClentic				
Nowak				
Ross	X	X		
Stafford	X	X		
Zannini	X	X		
TENNESSE				
Heater	X		X	
TEXAS				
Bennett	X	X		
Isbell	X		X	
Potter	X	X		

	APPROVED	CONFIRMED	CANCELLED	REMARKS
UTAH				
Plott				
Schnirel	X	X		
VERMONT				
Given	X	X		Use home address
WASHINGTON				
Putas	X	X		
Steele	X	X		
WISCONSIN				
Wandrei	X		X	

July 24, 1967

LIST OF PARTICIPANTS

SUMMER INSTITUTE

ALABAMA

Ralph Skinner
305 Vine Street
Bay Minette, Alabama 36507

CALIFORNIA

Alvin B. Auerbach
1240 47th Avenue
Sacramento, California 95831

Lawrence E. Gerevas
426 Coughlin Street
Vallejo, California

James E. Gonzalez
19425 Bryant Street
Northridge, California 91324

Joseph W. James
125 Helen Dr.
Fullerton, California 92631

John J. McVicar
Laney College
1001-3rd Ave.
Oakland, California 94606

Dean O. Peck
5301 Diablo Drive
North Highlands, California 95660

CONNECTICUT

John G. Bradshaw
94 Dover Rd.
West Hartford, Connecticut 06119

FLORIDA

Joel Feldman
224 N. E. 173 Street
Miami, Florida 33162

Lewis M. Sitz
7571 W. Kismet Street
Miramar, Florida 33023

Tommie Green
3720 Gum Street
Cocoa, Florida

GEORGIA

John J. Stewart
Route 3, Box 313
Thomaston, Georgia 30286

ILLINOIS

Eugene E. Marks
1048 Langdon
Freeport Senior High School
Freeport, Illinois 61032

IOWA

Jack A. Druart
2511 Sherwood Drive
Des Moines, Iowa 50310

MAINE

Richard M. Libby
R. F. O. #3
Flaggy Meadow Road
Gorham, Maine 04038

William L. Vassar
Central Maine Vocational-
Technical Institute
1250 Turner Street
Auburn, Maine 04210

MASSACHUSETTS

Paul L. Levesque
9 Kilton Street
Taunto, Massachusetts 02780

MINNESOTA

James S. Steen
530 N. 18th Ave. E.
Duluth, Minnesota 55812

NEW YORK

Jack Grossman
Alexander Hamilton V. & T. High School
150 Albany Avenue
Brooklyn 13, New York

John L. Mueller
New York City Community College
300 Pearl Street
Brooklyn, N. Y. 11201

OHIO

F. Travis Isbell
Lorain County Community College
1005 North Abbe Road
Elyria, Ohio 44035

OKLAHOMA

Bill J. Rutledge
Area Vocational-Technical Center
19th and Pine
Duncan, Oklahoma 73533

PENNSYLVANIA

Paul A. Graves
16 Harrison Street
Emmaus, Pennsylvania 18049

Paul L. McQuay
816 E. 3rd Street
Williamsport, Pa.

RHODE ISLAND

Robert C. Anderson
536 Middle Road
East Greenwich
Rhode Island

Raymond S. Amend
109 Gillan Avenue
Warwick, Rhode Island 02886

Edward J. Ross
114 River Avenue
Providence, Rhode Island 02908

Gilbert S. Stafford
Box 182 Old Post Rd.
Wakefield, R. I. 02879

Frank Zannini
236 River Side Ave.
Warwick, Rhode Island 02889

TEXAS

Gary S. Bennett
1618 Hughey Drive
Longview, Texas 75601

Charles F. Potter
Drafting Department
Henderson County Jr. College
Athens, Texas 75751

UTAH

James R. Schnirel
742 South 6th East
Salt Lake City, Utah 84102

VERMONT

James D. Given
N. Grove Street
Pittsford, Vermont 05763

WASHINGTON

William J. Putas
1745, 23rd Avenue
Longview, Washington 98632

James W. Steele
Route 2, Box 196
Spokane, Washington 99207

PARKING, TRAFFIC & MOTOR VEHICLE REGULATIONS

The Miami-Dade Junior College is within the unincorporated area of Dade County. Traffic regulations are enforced by the Metropolitan Dade County Sheriff's office. The standard traffic regulations and definitions as enacted into the motor vehicle laws of the State of Florida and Dade County are enforced at all times throughout the campus, including evening hours.

Students are not required to have decals on their cars but they must park cars only in areas designated for student parking. Staff and vendors are issued appropriate decals; disabled students are issued decals which allow them to park as near to their classes as possible. Decals should be placed on the lower left hand side of the rear window (behind the driver); on wrap-around windows, the decal should be placed so that it can be seen from the rear of the car. Decals on convertibles should be placed on the windshield in the lower right hand corner. Decals may be obtained by staff and faculty in Room 1177, Campus Services. Disabled students pick up applications in Room 1150, Health Services. Special areas are set aside for bicycles, scooters and motorcycles, also for Disabled personnel.

All persons who operate motor vehicles on Miami-Dade Junior College campus must park in spaces which are appropriate to their business on the campus. Visitors must obtain a visitor parking permit at the information booth located at the main entrance to the campus. Visitor's time is restricted. Information Booth is open from 8:00 a.m. to 8:00 p.m. Monday through Friday.

The speed limit throughout the campus is 15 miles per hour. No vehicles are allowed on the walks, grass or grounds area between campus buildings.

Vehicles must not be abandoned on campus. If a car is left on campus temporarily, the office of the Coordinator of Campus Services must be notified.

The college assumes no responsibility for the care or protection of any vehicle or its contents any time it is operated or parked on campus.

All Dade County regulations concerning motor vehicle operation are enforced on the campus including display of a Dade County automobile inspection sticker.

Citations may be given for the following traffic violations:

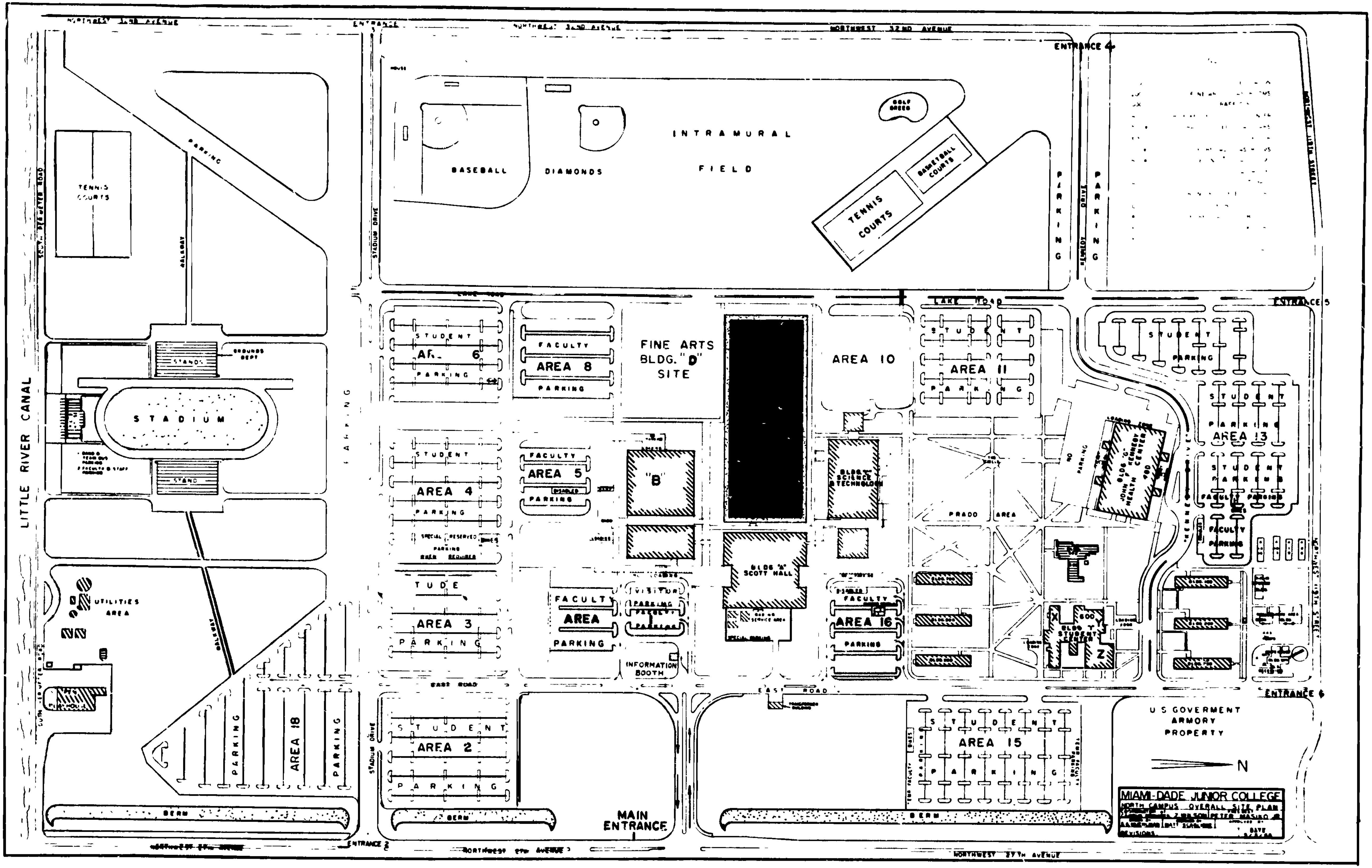
1. Failure to have an inspection sticker.
2. Reckless or drunken driving.
3. Driving in areas other than main thoroughfares.
4. Ignoring yield signs.
5. Misuse of parking privileges or parking in unauthorized areas.
6. Failure to yield to pedestrians in crosswalks.
7. Failure to conform to other regulations enforced by the Metropolitan Dade County Sheriff's Department.

NORTH CAMPUS

Campus Map Parking – Traffic & Motor Vehicle Regulations

MIAMI-DADE JUNIOR COLLEGE
11380 N. W. 27TH AVENUE
MIAMI, FLORIDA 33167

BUILDINGS
STUDENTS
GRASS



FROM: MIAMI-DADE JUNIOR COLLEGE
Office of Information Services
11380 N.W. 27th Avenue
Miami, Florida

FOR IMMEDIATE RELEASE

CONTACT: Ethel Tombrink
685-4457

Thirty-six educators from throughout the country will attend a Summer Institute for Computer-Aided Drafting and Design at Miami-Dade Junior College beginning Monday, July 10.

Supported by the United States Office of Education with a $19,762 federal grant, the three-week Institute is the first of its kind in the South, according to Dr. George Mehallis, director of M-DJC North's Division of Technical, Vocational and Semi-Professional Studies.

The "students", chosen from more than 100 applicants for the Institute, are instructors, supervisors and department chairmen in areas of drafting, engineering, manufacturing and computer technology at junior colleges, technical and area vocational schools in 20 states.

The course is designed to provide an understanding of, and experience in, industry's newest development in automation--computer--aided drafting and design, and its utilization. It will enable the educators to install such a program at their schools and/or to teach the course.

Experience will be given in programming of the IBM System 1620 with an on-line 1627 Plotter, a complicated machine that counts among its many talents drawing anything from Mona Lisa to a picture of the ocean floor and designing specialized tools and machinery.

Three languages will be used: the drafting language, COGO (Coordinate Geometry) used in civil engineering, and the language for numerical control.

(more)

Special presentations will be given by the Martin Company of Orlando; IBM Corp. of Poughkeepsie, N.Y.; Compudyne Corp. of Hatboro, Pa.; IBM Corp. and Stromberg-Carlson Inc. of Miami.

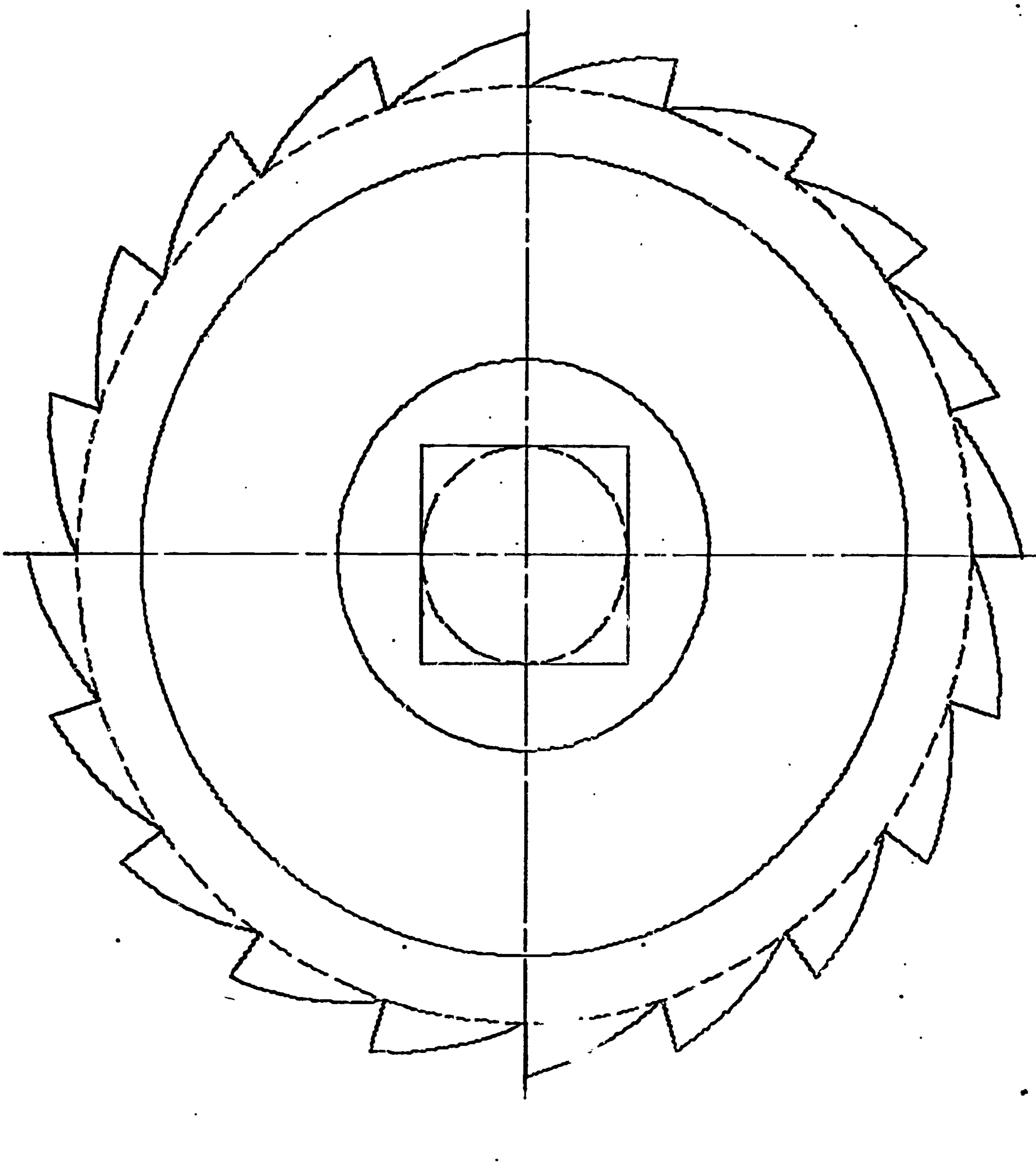
Field trips to Dade County companies utilizing computer-plotters will include Milgo Electronics Corp., and Automated Building Components, Inc., as well as the University of Miami Institute of Marine Science.

Members of the Miami-Dade staff, with Bruce DeSautel as principal lecturer, will instruct the Institute. Coordinator is Alex Morphonios, chairman of the Department of Instrumentation and Automation at Miami-Dade North. A similar course in computer application will be offered to students at both day and night school at the College this fall.

Addressing the Institute's opening session Monday will be R. T. Caldwell, technical consultant for the State Department of Education; Ambrose Garner, North Campus vice president, and Theodore Koechler, vice president for administration.

*****

ET:er
7/7/67



LIBBY PLATE 2

1967 SUMMER INSTITUTE

MIAMI-DADE JUNIOR COLLEGE

```
*LIST PRINTER
        BOX   =        VIEW   /
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                       DRAW   / BOX
                       ALPHAP/ (.2,.2,.2,0),(0,0,0,0)
                       TITLE/ 2.75,1.5,@LIBBY@
                       TITLE / 5.5,1.5,@PLATE 2@
    $$  DATE JULY 18, 1967
    $$  PLATE 2 SPIRAL CUTTER
        SQUARE=        VIEW   /
                       ORIGIN/ 4.125,6.625
                       LINE   / 0,0,DX,1.25
                       LINE   / PPP,DY,-1.25
                       LINE   / PPP,DX,-1.25
                       LINE   / PPP,DY,1.25
                       END    / SQUARE
                       DRAW   / SQUARE
        ROUND =        VIEW   /
                       ORIGIN/ 4.75,6
                DASHED,CIRCLE/ 0,0,.625
                       CIRCLE/ 0,0,1.125
                       CIRCLE/ 0,0,2.3075
                DASHED,CIRCLE/ 0,0,3-.3075
                          END/ ROUND
                         DRAW/ ROUND
        HCENTR=          VIEW/
                       CTRLN,   LINE/ -3.125,0,DX,6.25
                          END/ HCENTR
                         DRAW/ HCENTR
        VCENTR=          VIEW/
                CTRLN, LINE/ 0,-3.125,DY,6.25
                          END/ VCENTR
                         DRAW/ VCENTR
        DESIGN=          VIEW/
        C1     =CONSTR,CIRCLE/ 0,0,3
        C2     =CONSTR,CIRCLE/ 0,0,3-.3075
        Z      =18
        V      = 0
                       LOOPST/
    1)  LQ     =CONSTR,  LINE/ 0,0,ATANGL,Z,LENGTH,.1
        P1     =        POINT/ XLARGE,INTOF,LQ,C2
        LV     =CONSTR,  LINE/ 0,0,ATANGL,V,LENGTH,.1
        P2     =        POINT/ XLARGE,INTOF,LV,C1
                          ARC/ P1,P2,YSMALL,RADIUS,1.8175,CLW
                         LINE/ PPP,ATANGL,180+V,LENGTH,.3075
        Z      =Z+18
        V      =V+18
        IF(90-V)2,2,1
    2)                 LOOPND/
```
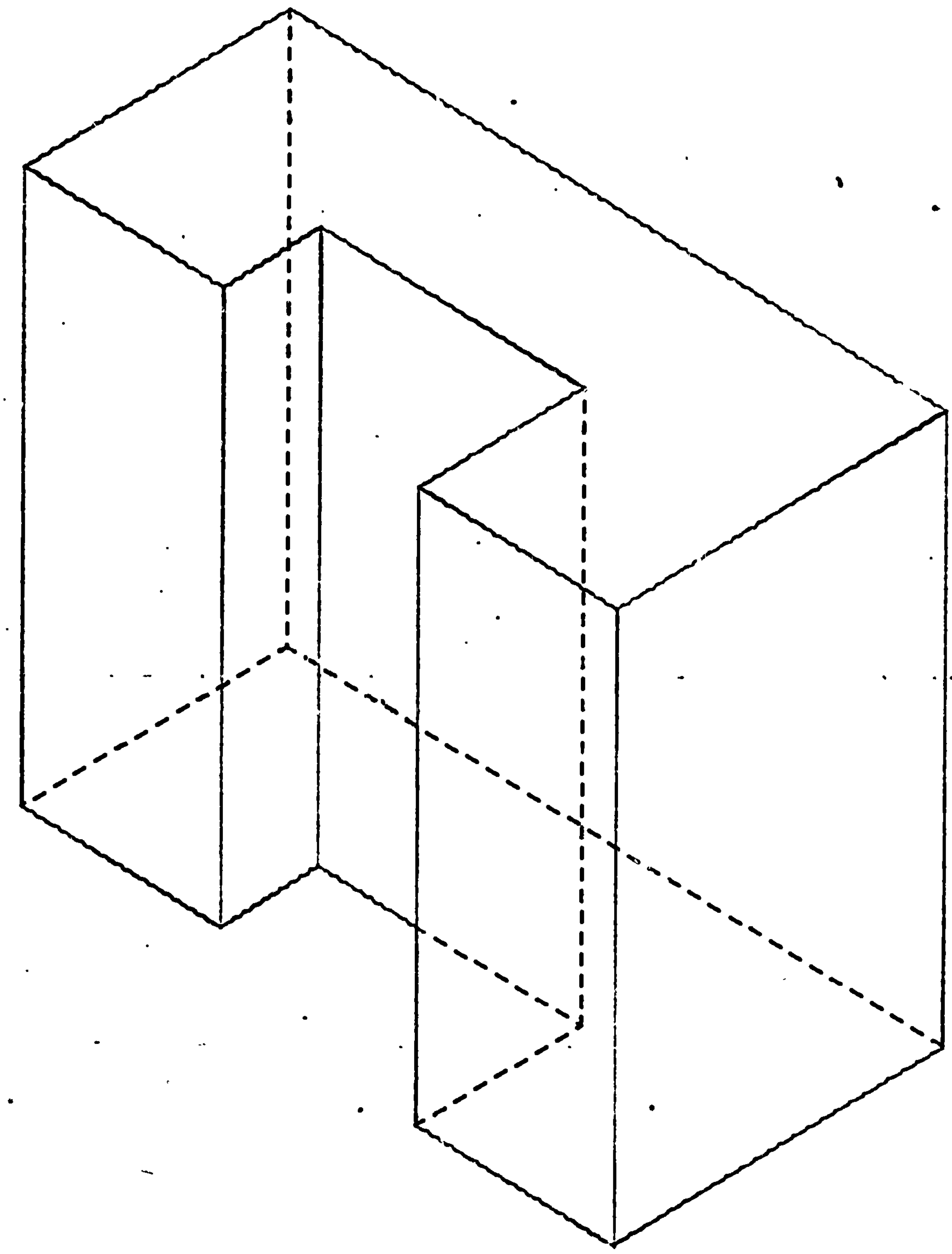

```
  END/DESIGN
ORIGIN/ 4.75,6
  DRAW/DESIGN
ORIGIN/4.75,6,ATANGL,90
  DRAW/DESIGN
ORIGIN/4.75,6,ATANGL,180
  DRAW/DESIGN
ORIGIN/4.75,6,ATANGL,270
  DRAW/DESIGN
  FINI/
```



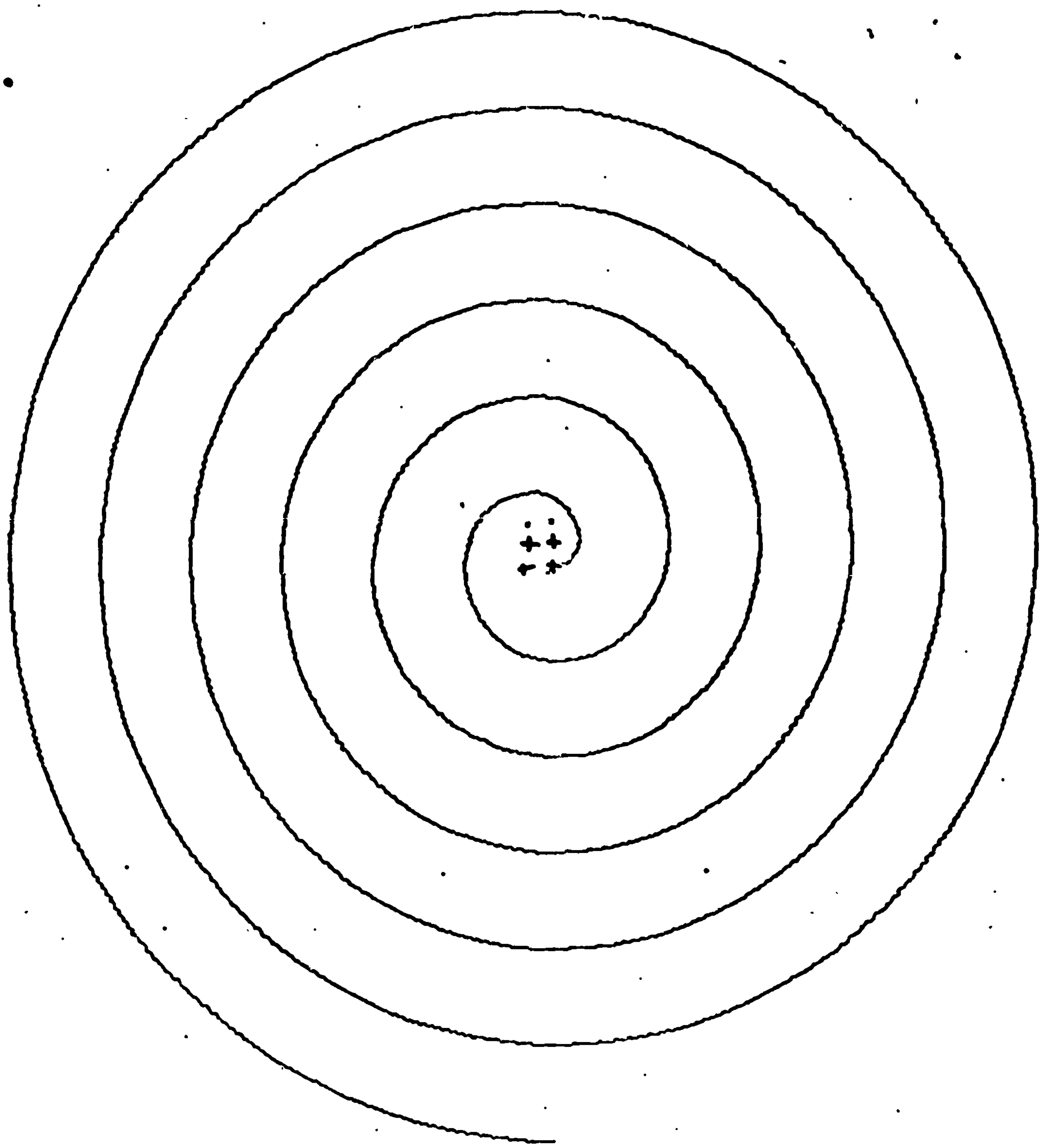
LEVESQUE PLATE PL

1967 SUMMER INSTITUTE

MIAMI-DADE JUNIOR COLLEGE

```
*LIST PRINTER
$$ PLATE   PL            ISOMETRIC
  BOX     =      VIEW   /
                 CALL   /FRAME1,,X=6.5,,Y=10,,ORX=1.5,,ORY=.5
                 END    /BOX
                 DRAW   /BOX
                 ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                 TITLE /6,1.5,@ PLATE PL @
ALPHAP / (.3,.3,.3,0),(0,0,0,0)
TITLE/ 2,1.5, @ LEVESQUE @
  ISOM    =      VIEW   /
                 ORIGIN/0,0
                 SCALE /.75
  P1      =      PT    / 7,4
                 LINE   / P1,ATANGL,30,LENGTH,2.5
  P2      =      PT     /PPP
                 LINE   /DY,4
  P3      =      PT     /PPP
                 LINE   /P3,ATANGL,210,LENGTH,2.5
  P4      =      PT     /PPP
                 LINE   /DY,-4
                 LINE   /PPP,ATANGL,150,LENGTH,1.5
  P5      =      PT     /PPP
          DOTTED,LINE   /P5,ATANGL,30,LENGTH,1.25
  P6      =      PT     /PPP
          DOTTED,LINE   /P6 ,DY,4
  P7      =      PT     /PPP
                 LINE   /P7,ATANGL,210,LENGTH,1.25
  P8      =      PT     /PPP
                 LINE   /P8,P4
  L1      =      LINE   /P8,P5
                 LINE   /P7,ATANGL,150,LENGTH,2
  P9      =      PT     /PPP
                 LINE   /P9,DY,-4
  P10     =      PT     /PPP
  L2      =CONSTR,LINE  /P10,P6
  P11     =      PT     /INTOF,L1,L2
                 LINE   /P10,P11
          DOTTED,LINE   /P11,P6
                 LINE   /P10,ATANGL,210,LENGTH,.75
  P12     =      PT     /PPP
                 LINE   /P12,DY,4
  P13     =      PT     /PPP
                 LINE   /P13,ATANGL,150,LENGTH,1.5
  P14     =      PT     /PPP
                 LINE   /P14,DY,-4
  P15     =      PT     /PPP
                 LINE   /P15,P12
                 LINE   /P9,P13
                 LINE   /P14,ATANGL,30,LENGTH,2
```

```
0050    P16    =        PT     /PPP
0051                    LINE   /P16,P3
0052    L3     =CONSTR,LINE    /P16,DY,-5
0053    L4     =CONSTR,LINE    /P15,ATANGL,30,TILLX,5
0054    P17    =        PT     /INTOF,L3,L4
0055           DOTTED,LINE     /P16,P17
0056           DOTTED,LINE     /P15,P17
0057           DOTTED,LINE     /P17,P2
0058                    END    /ISOM
0059                    DRAW   /ISOM
```

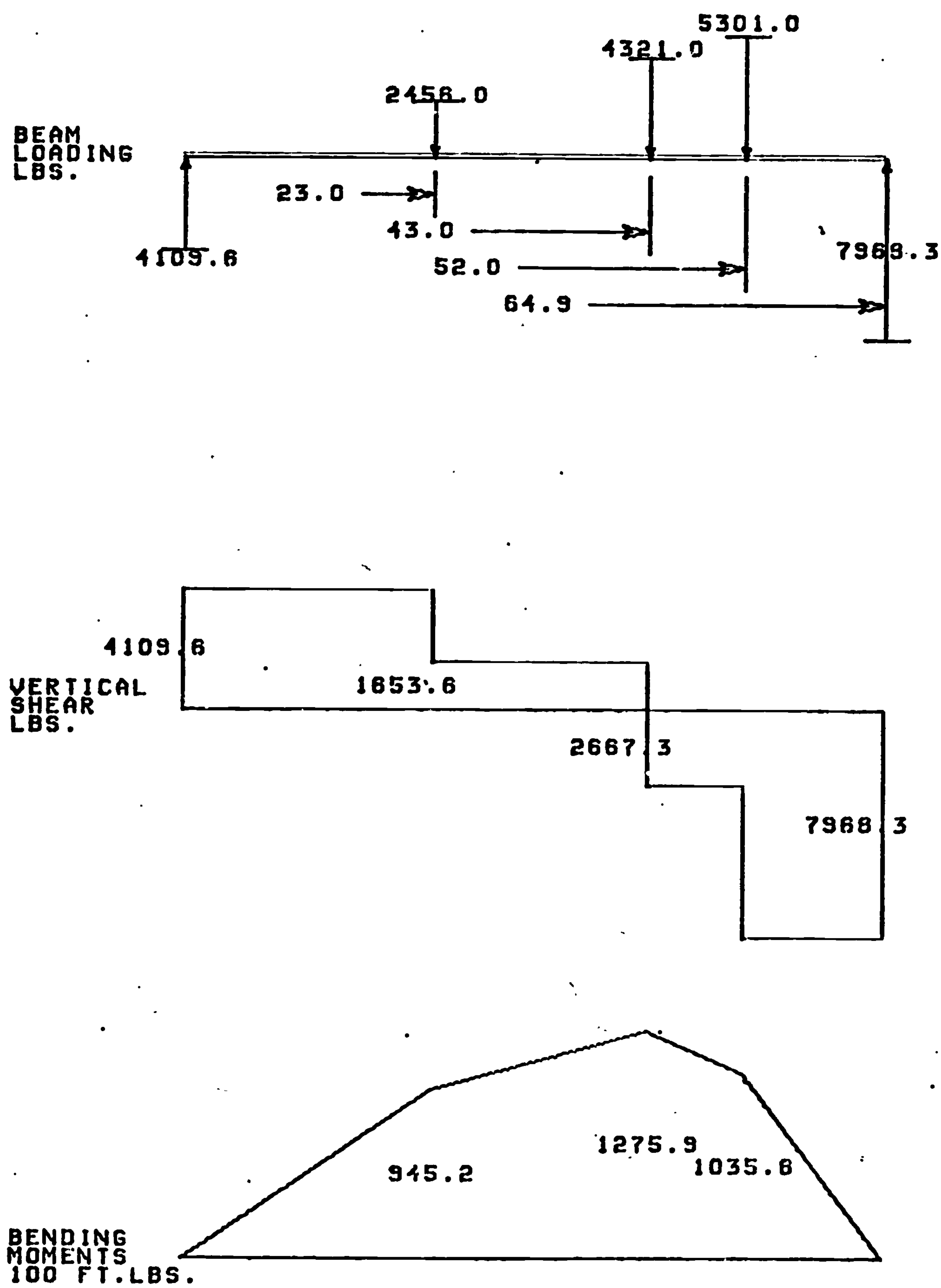


1967 SUMMER INSTITUTE

MIAMI-DADE JUNIOR COLLEGE

TED Ross

```
*LIST PRINTER
   BORDER=VIEW
 CALL/FRAME1,,X=6.5,,Y=10,,ORX=1.5,,ORY=.5
   END/BORDER
 DRAW/BORDER
   SPIRAL=      VIEW/
   P1       =    POINT /     .0625,.0625
   P2       =   POINT /     -.0625,.0625
   P3       = POINT /       -.0625,-.0625
   P4       = POINT /       .0625,-.0625
   RAD=0
                       LOOPST  /
6)IF(RAD-3)1,2,2
1)  RAD= RAD+.125
ARC/P1,RAD,270,90
   RAD=RAD+.125-
       ARC /P2,RAD,0,90
   RAD=RAD+.125-
ARC/P3,RAD,90,90
   RAD=RAD+.125-
ARC/P4,RAD,180,90
                       JUMPTO/6
2)LOOPND/
  END/SPIRAL
ORIGIN/4.625,11/2
    DRAW/SPIRAL
  FINI/
```



MUELLER

BEAM ANALYSIS

```
*LIST PRINTER
$$  GIVEN A BEAM OF ARBITRARY LENGTH WITH THREE CONCENTRATED
$$  LOADS AT ARBITRARY POINTS BETWEEN SUPPORTS, THIS PROGRAM
$$  COMPUTES THE REACTIONS, DRAWS THE SHEAR DIAGRAM, AND
$$   THE BENDING MOMENT DIAGRAM.
BOX=THICK,VIEW/
LN/1.5,.5,DX,6.5
LN/DY,10
LN/DX,-6.5
LN/DY,-10
LN/1.5,1.25,DX,6.5
END/BOX
DRAW/BOX
ALPHAP/(.4,.3,.4,0),(0,0,0,0)
TITLE/2.15,.875,@BEAM ANALYSIS@
ALPHAP/(.2,.2,.17,0),(0,0,0,0)
TITLE/5.5,1.5,@MUELLER@
ALPHAP/(.1,.1,.1,0),(0,-.1,0,0)
TITLE/1.8,2.6,@BENDING@,@MOMENTS@,@100 FT.LBS.@
TITLE/1.8,5.6,@VERTICAL@,@SHEAR@,@LBS.@
TITLE/1.8,8.6,@BEAM@,@LOADING@,@LBS.@
F1=2456,,F2=4321,,BL=65,,LF1=23,,LF2=43,, F3=5301,,LF3=52
  BEAM     =          VIEW  /
                      ORIGIN/2.75,2.5
RR=(LF1*F1+LF2*F2+LF3*F3)/BL
RL=F1+F2+F3-RR
                      LOOPST/
IF(RR-RL)1,1,4
1)KB=1.0/RL
2)KV=1.25/RL
3)                    JUMPTO/6
4)KB=1.0/RR
5)KV=1.25/RR
6)                    LOOPND/
                      SCALE /4/BL,KB
L1=THICK,LN/0,6/KB,DX,BL
L2=          LN/0,6/KB,DY,-RL
CONSTR,LN/PPP,DX,BL/32
LN/PPP,DX,-BL/16
L3=          LN/LF1,6/KB,DY,F1
CONSTR,LN/PPP,DX,BL/32
LN/PPP,DX,-BL/16
L4=          LN/LF2,6/KB,DY,F2
CONSTR,LN/PPP,DX,BL/32
LN/PPP,DX,-BL/16
L11=LN/LF3,6/KB,DY,F3
CONSTR,LN/PPP,DX,BL/32
LN/PPP,DX,-BL/16
L5=          LN/BL,6/KB,DY,-RR
CONSTR,LN/PPP,DX,BL/32
```

```
LN/PPP,DX,-BL/16
  P1        =         POINT /INTOF,L1,L2
  P2        =         POINT /INTOF,L1,L3
  P3        =         POINT /INTOF,L1,L4
P11=PT/INTOF,L1,L11
  P4        =         POINT /INTOF,L1,L5
END/BEAM
DRAW/BEAM
ALPHAP/(.2,.2,.17,0),(0,0,0,0)
NOTE/P1,@$AU$@
NOTE/P2,@$AD$@
NOTE/P3,@$AD$@
NOTE/P11,@$AD$@
NOTE/P4,@$AU$@
MASK/@HD1TN@
DIMP/1.1,.1,0,0
DIMST/XSMALL,YCOMP,L3,0
                      DIMNN /L3
DIMST/XSMALL,YCOMP,L4,0
                      DIMNN /L4
DIMST/XSMALL,YCOMP,L2,0
                      DIMNN /L2
DIMST/XSMALL,YCOMP,L11,0
DIMNN/L11
DIMP/.5,.1,0,0
DIMST/XSMALL,YCOMP,L5,0
                      DIMNN /L5
                      DIMP  /.5,.1,0,1
                      DIMST /YSMALL,XCOMP,L1,.2
                      DIMNE /P1,P2
                      DIMNE /P1,P3
DIMNE/P1,P11
                      DIMNE /P1,P4
SHDIA=VIEW/
                      SCALE /4/BL,KV   $$SHEAR DIAGRAM
LN/0,3/KV,DX,BL
L8=LN/0,3/KV,DY,RL
                      LN    /PPP,DX,LF1
                      LN    /PPP,DY,-F1
  P6        =         PT    /PPP
                      LN    /PPP,DX,LF2-LF1
                      LN    /PPP,DY,-F2
P12=PT/PPP
LN/PPP,DX,LF3-LF2
LN/PPP,DY,-F3
LN/PPP,DX,BL-LF3
L10=LN/PPP,DY,RR
L9=CONSTR,LN/P6,LF1,3/KV
L12=CONSTR,LN/P12,LF3,3/KV
END/SHDIA
DRAW/SHDIA
MASK/@HD1TN@
DIMP/.5,.1,0,0
DIMST/XSMALL,YCOMP,L8,.01/(4/BL)
```

```
                              DIMNN /L8
DIMST/XSMALL,YCOMP,L9,.01/(4/BL)
                              DIMNN /L9
DIMST/XSMALL,YCOMP,L12,.01/(4/BL)
DIMNN/L12
DIMST/XSMALL,YCOMP,L10,.01/(4/BL)
                              DIMNN /L10
BNDMO=VIEW/
M1=RL*LF1/100
M2=(RL*LF2-F1*(LF2-LF1))/100
M3=(RL*LF3-F1*(LF3-LF1)-F2*(LF3-LF2))/100
                              LOOPST/
IF(M1-M2)7,7,9
7)KM=1.25/M2
8)                            JUMPTO/1
9)KM=1.25/M1
1)LOOPND/
                              SCALE /4/BL,KM
                              LN    /0,0,DX,BL   $$BENDING MOMENT DIAGRAM
   LN/0,0,LF1,M1
P8=PT/PPP
LN/PPP,LF2,M2
P9=PT/PPP
LN/PPP,LF3,M3
P13=PT/PPP
                              LN    /PPP,BL,0
L6=CONSTR,LN/P8,LF1,0
L7=CONSTR,LN/P9,LF2,0
L13=CONSTR,LN/P13,LF3,0
END/BNDMO
DRAW/BNDMO
MASK/@HD1TN@
DIMP/.5,.1,0,0
                              DIMST /XSMALL,YCOMP,L6,0
                              DIMNN /L6
                              DIMST /XLARGE,YCOMP,L7,0
                              DIMNN /L7
DIMST/XSMALL,YCOMP,L13,0
DIMNN/L13
                              FINI/
```

Miami-Dade Junior College

Division of Technical, Vocational and Semiprofessional Studies

This is to Certify that

____

successfully completed the three week summer institute for

Computer-Aided Drafting and Design

In witness whereof we hereby affix our signatures

on this 28th day of July, 1967

George McKallis
Director

Alex Morphonios
Coordinator

Peter Masiko, Jr.
President

Ambrose Garner
Vice President

Miami-Dade Junior College
1967 Summer Institute
for
Computer-Aided Drafting and Design

QUESTIONNAIRE

1. Has the Institute provided a basis for your understanding, programming, and utilization of Industry's development of Computer-Aided Drafting and Design?

2. Has this Institute developed an interest, basic knowledge, and skill essential for teaching and/or evaluation of courses in the area of Computer-Aided Drafting and Design?

3. Has the course material including course content, references, visual, and other instructional aids been suitable for use as patterns and guide lines for future programs?

4. Did the presentations by Industry and the field trips contribute sufficient information to the Institute to justify the time and effort devoted to this area of activity?

5. Evaluation of the Institute's:

   A. Program-

   B. Operation-

   C. Facilities-

D. Instruction

1. Drafting Language

   a. Lecture

   b. Laboratory

2. COGO

   a. Lecture

   b. Laboratory

3. Numerical Control

   a. Lecture

   b. Laboratory

4. FORTRAN

   a. Lecture

   b. Laboratory

6. Suggestions-

7. Summary Remarks-

SUMMARY REMARKS
from
Participant's Questionnaire

Miami-Dade Junior College
1967 Summer Institute
for
Computer-Aided Drafting and Design

"In general I feel that I gained much more from the institute than I had expected--This due to the planning and execution of the program as a whole."
Mr. Charles F. Potter, Henderson County Jr. College, Texas

"I felt the course was a hugh success. I am truly amazed that I have been able to digest so much information. I was apprehensive about the proclaimed goals of the institute but find that I really understand and can work with the drafting and cogo languages."
Mr. James S. Steen, Duluth Area Institute of Technology, Minnesota.

"I feel I have received much more information and even training in the field than I had anticipated. I would be very interested in a course on CRT design."
Mr. Gilbert S. Stafford, Rhode Island Junior College, Rhode Island.

"Very worthwhile--glad I was chosen to attend. I will attempt to implement a course next fall (1968) particularly geared to machine drawing by computer."
Mr. John J. Stewart, Upson County Area Vocational, Georgia

"I've enjoyed the institute both from the stand point of instruction in the drafting language and fellow acquaints. I would recommend Dade Jr. College continue in this field of workshops. I would like to return for an institute in fortran."
Mr. Joseph W. James, Fullerton Junior College, California.

"Thanks for the opportunity of attending this institute. It will be most helpful in starting a program of computerized drafting at our school."
Mr. James E. Gonzalez, Glendale College, California.

"The cooperation of the staff was a wonderful experience and all members agreed on this."
Mr. John G. Bradshaw, Hartford State Technical Institute, Connecticut.

"Your school is making great progress--More of these summer institutes to keep the technical teacher up to date. It is very hard for teachers to keep up with industry. Thanks for selecting me."
Mr. Gary S. Bennett, Kilgore College, Texas.

"Mr. DeSautel is one of the finest instructors I have had. He has all the attributes and talents of an ideal teacher. He made the difficult seem easy."
Mr. Lawrence E. Gerevas, Napa Junior College, California

"I really feel that I have had a good introduction to this computer field. To this end the course met my every expectations. I plan to continue in this area and push EDP in my area. The course was in general excellent."
Mr. James R. Schnirel, Utah Technical College, Utah.

"Mr. Bruce DeSautel presented the course material in a manner so that I was able to understand and fully participate in the program. I have discussed the lab previously. It is my feeling that I have the basic knowledge of computers to go back to Maine and start working on a program at my school (cmvti). This, I feel will be strictly an adult upgrading program at this time, eventually being adopted in the day classes. If another institute is held, especially in fortran, I would definitely be an applicant."
Mr. William L. Vassar, Central Maine Vocational-Technical Institute, Maine.

"I'm sure this institute will enable me to help our schools in Vermont to a possible set up in drafting language. Thank you for the opportunities."
Mr. James D. Given, Rutland Senior High School, Vermont.

"The over all program was very well organized and pleasent. Three weeks is a good length. Shorten the time and I feel something would be lost. Students not familiar with the programs covered need the time to digest the material and debug their programs."
Mr. Jack A. Druart, Des Moines Technical High School, Iowa.

"An excellent course. Please notify me of any subsequent courses and institutes in the drafting field. The long trip is worthwhile."
Mr. John J. McVicar, Laney College, California.

"I feel that the course has given me a very strong background in drafting (that is computer aided drafting) and I only hope that I can put this to use as soon as possible. Hope for a follow-up course next summer."
Mr. Paul L. Levesque, Taunton High School, Massachusetts.

"I have been afraid of computers because I did not fully understand their operation. I can now say that I have confidence, understand their use, and that I will definitely continue to study data processing. I will strive to introduce their use in our technical department. I would recommend continued offering of this institute by this college."
Mr. Frank Zannini, Roger Williams Junior College, Rhode Island.

MIAMI-DADE JUNIOR COLLEGE MIAMI, FLORIDA

north campus 11380 n. w. 27th avenue
miami, florida 33167

ivision of Technical,
Vocational, and
miprofessional Studies
lephone: 685-4301-2-3

September 22, 1967

Mr. J. B. Simmon, Director
Technical Education
Henderson County Junior College
Cardinal Drive
Athens, Texas 75751

Reference: Mr. Charles Potter's participation in the Summer Institute for Computer-Aided Drafting and Design.

Dear Sir:

I am pleased to inform you that your candiate has successfully completed the three week Summer Institute for Computer-Aided Drafting and Design. This institute was held at Miami-Dade Junior College from July 10th through July 28th.

The institute was conducted for a period of seven and one-half hours each week day. The certificate that your candiate has received is equivalent to a three credit hour course at Miami-Dade Junior College.

All of the objectives of the institute have been fulfilled and your institution is to be congratulated for the commendable performance of your representative.

Sincerely yours,

Alex G. Morphonios
Institute Coordinator

bmj

cc: Dr. George Mehallis
Mr. Theodore Koschler
Mr. John Kelly

south campus 11011 s. w. 104th street
miami, florida 33156

miami beach center 1410 drexel avenue
miami beach, florida 33139

DES MOINES TECHNICAL HIGH SCHOOL
1800 GRAND AVENUE
DES MOINES, IOWA 50307

ELMER C. BETZ, PRINCIPAL
ROLLAND E. BROWNELL, VICE PRINCIPAL
MARY ANNE MCMANUS, ADVISER
IO MCGILVRA, REGISTRAR

September 19, 1967

Mr. Alex G. Morphonios
Institute Coordinator
Miami-Dade Junior College
11380 N. W. 27th Avenue
Miami, Florida 33167

Dear Mr. Morphonios:

Thank you for your letter about the participation of our Mr. Jack Druart in your Summer Institute for Computer-Aided Drafting and Design.

We much appreciate your writing us and confirming for us the commendable performance which we predicted for him last summer.

We appreciate the hospitality and instructional assistance which you extended to him.

Sincerely,

E. C. Betz
E. C. Betz
Principal

ECB:ow

FJC

Division of Technical Education

Fullerton Junior College 321 East Chapman Avenue Fullerton, California 92634 Telephone 871-8000

October 2, 1967

Alex G. Morphonios
Miami-Dade Junior College
North Campus, 11380 N.W. 27th Ave.
Miami, Florida, 33167

Dear Mr. Morphonios:

I would like to convey to you, as best I can, an expression of my genuine appreciation to you and your administration for the successful summer institute for Computer-Aided Drafting and Design.

I particularly want to express my gratitude for the part which you played. Your courtesy and friendliness helped to make the stay interesting and enjoyable to all of us.

The subject, computerized drafting, is so vast, touches so many fields and is so vital a part of the world's life today that practical wisdom,of a person like Bruce DeSautel,devoted to this subject, is a benefit conferred on us all.

Again, I want to convey to you [illegible] appreciation of the kindness on the part of your entire technical staff for making the program an interesting and profitable experience. You have an outstanding school there, and I should like to be a part of another institute program if one should occur.

Sincerely,

J. W. James

Joseph W. James, Chairman
Technical Education Division

cc: Mr. Bruce L. Desautel
Mr. G. Mehallis

1967 SUMMER INSTITUTE

MIAMI-DADE JUNIOR COLLEGE

PREFACE

This notebook contains the reference material and programming exercises used for the Computer Aided Drafting Summer Institute at Miami-Dade Junior College, July 10-28, 1967.

The exercises are to be programmed for execution on the IBM System 1620 with an on-line 1627 plotter. The exercises provide a medium for covering and enforcing the subject material.

Each participant in the Summer Institute will receive the programmed solutions for the 1620 and the output from the 1627 for the exercises in this notebook. The programs are not necessarily the most efficient and practical solutions to the exercises. These programs attempt to include only that portion of the subject material familiar to the participant and in sequence with the class lecture.

Bruce L. DeSautel

PARTICIPANTS

STATE	SCHOOL	CITY
ALABAMA		
Skinner	W. L. Yancey State Junior College	Bay Minette
CALIFORNIA		
Auerbach	Sacramento City College	Sacramento
Gerevas	Napa Junior College	Vallejo
Gonzalez	Glendale College	Glendale
James	Fullerton Junior College	Fullerton
McVicar	Laney College	Oakland
Peck	American River College	Sacramento
CONNECTICUT		
Bradshaw	Hartford State Technical Institute	Hartford
FLORIDA		
Feldman	Hialeah High School	Miami
Green	Monroe High School	Cocoa
Myers	Satellite High School	Satellite Beach
Sitz	New River High School	Ft. Lauderdale
GEORGIA		
Stewart	Upson County Area Vocational	Thomaston
ILLINOIS		
Marks	Highland Junior College	Freeport
IOWA		
Druart	Des Moines Technical High School	Des Moines
MAINE		
Libby	Portland High School	Portland
Vassar	Central Maine Vocational Technical Institute	Auburn
MASSACHUSETTS		
Levesque	Taunton High School	Taunton
MINNESOTA		
Steen	Duluth Area Institute of Technology	Duluth
NEW YORK		
Grossman	Alex Hamilton Voc & Tech High School	Queens
Mueller	New York City Community College	Brooklyn
OHIO		
Isbell	Lorraine County Community College	Elyria
OKLAHOMA		
Rutledge	Area Vocational-Technical Center	Duncan

PARTICIPANTS
(cont.)

STATE	SCHOOL	CITY
PENNSYLVANIA		
Graves	The Williamsport Area Community College	Williamsport
McQuay	The Williamsport Area Community College	Williamsport
RHODE ISLAND		
Anderson	Pilgrim High School	Warwick
Amend	Warwick Veterans High School	Warwick
Ross	Rhode Island Junior College	Providence
Stafford	Rhode Island Junior College	Providence
Zannini	Roger Williams Junior College	Providence
TEXAS		
Bennett	Kilgore College	Kilgore
Potter	Henderson County Junior College	Athens
UTAH		
Schnirel	Utah Technical College	Salt Lake City
VERMONT		
Given	Rutland Senior High School	Rutland
WASHINGTON		
Putas	Lower Columbia College	Longview
Steele	Spokane Community College	Spokane

1967 SUMMER INSTITUTE
SCHEDULE

FIRST WEEK

	TOPIC	LECTURER	ROOM
MONDAY JULY 10, 1967			
8.00- 9.00 A.M.	REGISTRATION		3101
9.00-10.30 A.M.	PRESIDING	DR. G. MEHALLIS DIRECTOR, DIV. OF TECH. VOC. AND SEMI-PROFESSIONAL STUDIES	3101
	WELCOME	MR. A GARNER VICE PRESIDENT	
	FACILITIES	MR. T. KOSCHLER VICE PRESIDENT	
	FLORIDA GREETING	MR. R. CALDWELL STATE DEPT. OF ED.	
	INSTITUTE FORMAT	MR. A. MORPHONIOS INSTITUTE COORDINATOR	
10.30-10.45 A.M.	COFFEE BREAK		
10.45-12.00 A.M.	TOUR OF MIAMI-DADE JUNIOR COLLEGE	MR. A. MORPHONIOS MR. W. TRAVERS	
12.00- 1.00 P.M.	LUNCH		
1.00- 4.30 P.M.	INTRO. DATA PROCESS.	MR. B. DESAUTEL	1155

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	TOPIC	LECTURER	ROOM
TUESDAY JULY 11, 1967			
8.00-10.00 A.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
10.00-12.00 A.M.	LABORATORY, GROUP A LABORATORY, GROUP B	ASSISTANTS ASSISTANTS	1164 1155
12.00- 1.00 P.M.	LUNCH		
1.00- 2.00 P.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
2.00- 4.00 P.M.	LABORATORY, GROUP A LABORATORY, GROUP B	ASSISTANTS ASSISTANTS	1155 1164
4.00- 4.30 P.M.	OPEN LABORATORY	ASSISTANTS	1164

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	TOPIC	LECTURER	ROOM
WEDNESDAY JULY 12, 1967			
8.00-10.00 A.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
10.00-12.00 A.M.	LABORATORY, GROUP A	ASSISTANTS	1164
	LABORATORY, GROUP B	ASSISTANTS	1155
12.00- 1.00 P.M.	LUNCH		
1.00- 2.00 P.M.	AIDS PROJECT	MR. C. SMITH IBM SYSTEMS ENGINEER MIAMI, FLORIDA	3101
2.00- 4.00 P.M.	LABORATORY, GROUP A	ASSISTANTS	1155
	LABORATORY, GROUP B	ASSISTANTS	1164
4.00- 4.30 P.M.	OPEN LABORATORY	ASSISTANTS	1164
THURSDAY JULY 13, 1967			
8.00-10.00 A.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
10.00-12.00 A.M.	LABORATORY, GROUP A	ASSISTANTS	1164
	LABORATORY, GROUP B	ASSISTANTS	1155
12.00- 1.00 P.M.	LUNCH		
1.00- 4.30 P.M.	FIELD TRIP MILGO ELECTRONIC CORP. MIAMI, FLORIDA	MR. M. MC HUGH PERSONNEL MANAGER MR. H. THORSEN MARKETING MANAGER	
	AUTOMATED BUILDING COMP. MIAMI, FLORIDA	MR. O. KARSH COMPUTER SYSTEMS ENGR.	
FRIDAY JULY 14, 1967			
8.00- 9.00 A.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
9.00-10.30 A.M.	ENGR. DATA MANAGEMENT	MR. A. LEGO THE MARTIN COMPANY ORLANDO, FLORIDA	2151
10.30-12.00 P.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
12.00- 1.00 P.M.	LUNCH		

	TOPIC	LECTURER	ROOM
1.00- 4.00 P.M.	GRAPHIC SCIENCE	MR. N. MICHELSON SPECIAL REP. IBM CORPORATION POUGHKEEPSIE, N.Y.	2151
4.00- 4.30 P.M.	LABORATORY, GROUP A	ASSISTANTS	1155
	LABORATORY, GROUP B	ASSISTANTS	1164

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S E C O N D W E E K

MONDAY JULY 17, 1967

8.00-10.00 A.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
10.00-12.00 A.M.	LABORATORY, GROUP A	ASSISTANTS	1164
	LABORATORY, GROUP B	ASSISTANTS	1155
12.00- 1.00 P.M.	LUNCH		
1.00- 2.00 P.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
2.00- 4.00 P.M.	LABORATORY, GROUP A	ASSISTANTS	1155
	LABORATORY, GROUP B	ASSISTANTS	1164
4.00- 4.30 P.M.	OPEN LABORATORY	ASSISTANTS	1164

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TUESDAY JULY 18, 1967

8.00-10.00 A.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
10.00-12.00 A.M.	LABORATORY, GROUP A	ASSISTANTS	1164
	LABORATORY, GROUP B	ASSISTANTS	1155
12.00- 1.00 P.M.	LUNCH		
1.00- 2.00 P.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
2.00- 4.00 P.M.	LABORATORY, GROUP A	ASSISTANTS	1155
	LABORATORY, GROUP B	ASSISTANTS	1164
4.00- 4.30 P.M.	OPEN LABORATORY	ASSISTANTS	1164

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WEDNESDAY JULY 19, 1967

8.00-10.00 A.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
10.00-12.00 A.M.	LABORATORY, GROUP A	ASSISTANTS	1164
	LABORATORY, GROUP B	ASSISTANTS	1155
12.00- 1.00 P.M.	LUNCH		

	TOPIC	LECTURER	ROOM
1.00- 2.30 P.M.	STROMBERG-CARLSON CORPORATION	MR. D. LANDRY DISTRICT MANAGER MR. J. PIRKLE SYSTEM REP.	3101
2.30- 4.30 P.M.	LABORATORY, GROUP A	ASSISTANTS	1155
	LABORATORY, GROUP B	ASSISTANTS	1164

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THURSDAY JULY 20, 1967

8.00-10.00 A.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
10.00-12.00 A.M.	LABORATORY, GROUP A	ASSISTANTS	1164
	LABORATORY, GROUP B	ASSISTANTS	1155
12.00- 1.00 P.M.	LUNCH		
1.00- 2.00 P.M.	DRAFTING LANGUAGE	MR. B. DESAUTEL	1155
2.00- 4.00 P.M.	LABORATORY, GROUP A	ASSISTANTS	1155
	LABORATORY, GROUP B	ASSISTANTS	1164
4.00- 4.30 P.M.	OPEN LABORATORY	ASSISTANTS	1164

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FRIDAY JULY 21, 1967

8.00-10.00 A.M.	REVIEW OF DRAFTING LANG.	MR. B. DESAUTEL	1155
10.00- 2.00 P.M.	OPEN LABORATORY	ASSISTANTS	1164
12.00- 1.00 P.M.	LUNCH		
1.00- 4.30 P.M.	FIELD TRIP INST. OF MARINE SCIENCE UNIVERSITY OF MIAMI	DR. F. SMITH DIRECTOR MR. D. SHAFFER MANAGER COMP. CENTER	

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T H I R D W E E K

MONDAY JULY 24, 1967

8.00-11.00 A.M.	LECTURE NUMERIC CONTROL	MR. J. CORBIN	1155
11.00-12.00 A.M.	COMPUDYNE CORPORATION	MR. J. SMITH DIST. SALES ENGR. HATBORO, PA.	3101
12.00- 1.00 P.M.	LUNCH		

	TOPIC	LECTURER	ROOM
1.00- 4.30 P.M.	LABORATORY		3117

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TUESDAY JULY 25, 1967

8.00-12.00 A.M.	LECTURE NUMERIC CONTROL	MR. A. POH	1155
12.00- 1.00 P.M.	LUNCH		
1.00- 4.30 A.M.	LECTURE COGO	MR. B. DESAUTEL	1155

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WEDNESDAY JULY 26, 1967

8.00-10.00 A.M.	LECTURE COGO	MR. B. DESAUTEL	1155
10.00-12.00 A.M.	LABORATORY, GROUP A	ASSISTANTS	1164
	LABORATORY, GROUP B	ASSISTANTS	1155
12.00- 1.00 P.M.	LUNCH		
1.00- 2.00 P.M.	LECTURE COGO	MR. B. DESAUTEL	1155
2.00- 4.00 P.M.	LABORATORY, GROUP A	ASSISTANTS	1155
	LABORATORY, GROUP B	ASSISTANTS	1164
4.00- 4.30 P.M.	OPEN LABORATORY	ASSISTANTS	1164

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THURSDAY JULY 27, 1967

8.00-10.00 A.M.	LECTURE COGO	MR. B. DESAUTEL	1155
10.00-12.00 A.M.	LABORATORY, GROUP A	ASSISTANTS	1164
	LABORATORY, GROUP B	ASSISTANTS	1155
12.00- 1.00 P.M.	LUNCH		
1.00- 2.00 P.M.	LECTURE COGO	MR. B. DESAUTEL	1155
2.00- 4.00 P.M.	LABORATORY, GROUP A	ASSISTANTS	1155
	LABORATORY, GROUP B	ASSISTANTS	1164
4.00- 4.30 P.M.	OPEN LABORATORY	ASSISTANTS	1164

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FRIDAY JULY 28, 1967

8.00-10.00 A.M.	LECTURE COGO	MR. B. DESAUTEL	1155
10.00-12.00 A.M.	OPEN LABORATORY	ASSISTANTS	1164
12.00- 1.30 P.M.	PRESIDENTS LUNCHEON	DR. P. MASIKO PRESIDENT	1324

	TOPIC	LECTURER	ROOM
1.30- 4.30 P.M.	SUMMER INSTITUTE REVIEW	MR. B. DESAUTEL	1155

NOTES,

1. ASSISTANTS MR. L. ROSE
   MR. R. MACFARLANE
   MR. W. THOMPSON

2. ROOM 1164-IBM SYSTEM 1620

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1967 SUMMER INSTITUTE
LABORATORY ASSIGNMENTS

NAME	GROUP	TEAM
AMEND	A	5
ANDERSON	B	6
AUERBACH	B	1
BENNETT	A	5
BRADSHAW	B	2
DRUART	B	3
FELDMAN	A	2
GEREVAS	B	1
GIVEN	A	6
GONZALEZ	A	1
GRAVES	A	4
GREEN	A	2
GROSSMAN	A	4
ISBELL	A	4
JAMES	A	1
LEVESQUE	A	3
LIBBY	A	3
MARKS	A	3
MC QUAY	B	4
MC VICAR	B	1
MUELLER	B	4
MYERS	B	2
PAPPAS	B	6
PECK	A	2
POTTER	B	5
PUTAS	A	6
ROSS	B	5
RUTLEDGE	B	4
SCHNIREL	A	6
SKINNER	A	6
STAFFORD	A	5
STEELE	B	6
STEEN	B	3
STEWART	B	2
VASSER	B	3
ZANNINI	B	5

1 9 6 7 S U M M E R I N S T I T U T E
SUBJECT MATERIAL FOR LABORATORY LECTURES

I LABORATORY LECTURE 1

A. HARDWARE CONTAINED IN THE SYSTEM 1620 LABORATORY
1. 1620 CENTRAL PROCESSING UNIT AND CONSOLE
2. 1623 CORE STORAGE
3. 1627 PLOTTER
4. 1311 DISC STORAGE
5. 1622 CARD READ PUNCH
6. 1443 PRINTER
7. 026 CARD PUNCH

B. PRINCIPLES OF STORED PROGRAM OPERATION
1. STORAGE AND RETRIEVAL OF DATA
2. PROGRAMS-A SPECIAL KIND OF DATA

C. LANGUAGES IN WHICH PROGRAMS ARE WRITTEN
1. MACHINE OR OBJECT LANGUAGE
2. ASSEMBLY LANGUAGE
3. FORTRAN
4. DRAFTING LANGUAGE
5. COGO

D. DEMONSTRATION
1. A MACHINE LANGUAGE DRAWING USING THE PLOTTER
2. A FORTRAN-II PROGRAM
3. A DRAFTING LANGUAGE PROGRAM

II LABORATORY LECTURE 2

A. OPERATION OF THE 026 PRINTING CARD PUNCH
1. ALPHABETIC MODE
2. NUMERIC MODE
3. CARD CONTROL

B. OPERATION OF THE 1620 CONSOLE
1. MANUAL AND AUTOMATIC MODES
2. START AND STOP KEYS
3. SIGNAL LIGHTS
4. INPUT AND OUTPUT FROM THE CONSOLE TYPEWRITER

C. OPERATION OF THE 1622 READER
1. INSERTION OF PUNCHED CARDS
2. LOADING A PROGRAM
3. USE OF THE START BUTTON
4. NONPROCESS RUNOUT
5. READER LIGHTS

D. OPERATION OF THE 1443 PRINTER
1. START AND STOP KEYS
2. CARRIAGE CONTROL

E. OPERATION OF THE 1627 PLOTTER
1. RAISING AND LOWERING THE DRAWING PEN
2. MOVEMENT OF THE PEN AND DRUM DURING DRAWING
3. GROSS AND FINE ADJUSTMENT OF THE PEN POSITION
4. PLACING AND REMOVAL OF PAPER FOR DRAWINGS

F. FUNCTION OF THE 1311 DISC UNIT
1. RANDOM ACCESS STORAGE
2. INTERMEDIATE STORAGE

1967 SUMMER INSTITUTE
SUBJECT MATERIAL FOR DRAFTING LANGUAGE

I INTRODUCTION

II ORIENTATION

A. CLASS OUTLINE
B. STUDENT NOTEBOOKS
C. LABORATORIES

III INTRODUCTION TO DATA PROCESSING

A. HISTORY
B. EVOLUTION OF COMPUTERS
C. 1620 MACHINE LANGUAGE
   1. INSTRUCTIONS
   2. ADDRESSES
   3. LOGIC
   4. ARITHMETIC
D. PRODUCING A PROGRAM

IV PROCEDURE FOR PRODUCING A PROGRAM

V DRAFTING LANGUAGE PROCESSORS

A. COMPILER
B. PART PROCESSOR
C. DRAWING PROCESSOR

VI PARTS OF A DRAFTING LANGUAGE PROGRAM

A. GEOMETRIC GROUPS
   1. VIEW
   2. SHAPE
   3. END
B. OBJECT LINES
C. DRAWING STATEMENTS
   1. SCALE
   2. ORIGIN
   3. DRAW

VII LANGUAGE FORMAT AND CODING

A. LANGUAGE WORDS
   1. MAJOR
   2. MODAL
B. USER-CREATED WORDS
   1. NUMBERS
   2. LABELS
C. PUNCTUATION
   1. COMMA
   2. EQUAL
   3. SLASH
   4. PLUS-MINUS

5. DOLLAR SIGN
6. BLANK

D. LINE CLASSIFICATION
1. MEDIUM
2. THICK

VIII POINTS

A. INTRODUCTION
1. RECTANGULAR COORDINATES
2. PPP

IX LINES

A. INTRODUCTION
1. POINT TO POINT
2. RELATIVE DISTANCE
3. DISTANCE FROM PPP

X CIRCLES

A. INTRODUCTION
1. CENTER POINT AND RADIUS

XI LINES

A. FROM A POINT AT AN ANGLE TO THE X-AXIS

XII LETTERING

A. INTRODUCTION
1. ALPHAP
2. TITLE
3. LITERALS

XIII ARC

A. INTRODUCTION
1. BETWEEN TWO POINTS

XIV MACRO

A. INTRODUCTION
1. MACRO/
2. TERMAC/
3. DEFINE PARAMETERS OF A MACRO
4. CALL

XV DIMENSIONING

A. INTRODUCTION
1. DIMST
2. DIMP
3. MASK

4. DIM

XVI LINES

A. DISTANCE FROM PPP
B. INTERSECTION OF A LINE AND A CIRCLE

XVII CIRCLES

A. CENTER AND RADIUS OF AN ARC
B. DEFINED BY THREE POINTS

XVIII ARC

A. FILLETING

XIX GEOMETRIC FUNCTIONS

A. DXOF
B. DYOF
C. DIST
D. ATAND
E. PARAM

XX HATCHING

XXI LOOPING

XXII ARITHMETIC FUCTIONS

A. INTRODUCTION
1. SIND
2. COSD
3. ATAND
4. SQRT
5. ABS
6. ALOG

1967 SUMMER INSTITUTE
SUBJECT MATERIAL-NUMERIC CONTROL

I HISTORY AND DEVELOPMENT

A. CONCEPTION
B. DEVELOPMENT
C. SIMPLIFICATION

II PRESENT APPLICATIONS OF NUMERIC CONTROL

A. PROCESS CONTROLS
B. APPLICATION TO MACHINE TOOLS

III MANUAL PROGRAMMING

A. CODE AND LANGUAGE
B. POINT TO POINT PROGRAMMING
C. CONTINUOUS PATH PROGRAMMING

IV LABORATORY WORK

A. PROBLEM USING POINT TO POINT PROGRAMMING-PRATT AND WHITNEY TAPEOMATIC DRILL
B. DEMONSTRATION OF CONTINUOUS PATH MILLING OPERATIONS-COMPUDYNE 3 AXIS CONTINUOUS PATH MILLING MACHINE

SUBJECT MATERIAL-THE COMPUTERS ROLE IN NUMERICAL CONTROL

V INTRODUCTION

A. THE PART PROGRAMMER
B. PROGRAMMING FOR POINT TO POINT POSITIONING
C. PROGRAMMING FOR CONTOUR MACHINING
D. PROGRAM CHECKING-TAPE VERIFICATION
E. PROGRAMMING LANGUAGE
F. DESIGN AUTOMATION

VI INFORMATION PROCESSING AND STORAGE

VII THE AUTOSPOT II SYSTEM

A. GENERAL APPLICATION DESCRIPTION
   1. SAMPLE PROGRAM
   2. THE AUTOSPOT II LANGUAGE
   3. VOCABULARY AND STATEMENTS
   4. PROCESSOR ORGANIZATION
B. POINT TO POINT AUTOSPOT II PROGRAMMING
   1. DEFINITION STATEMENTS
   2. MACHING STATEMENTS
   3. SPECIAL STATEMENTS
   4. PUNCTUATION
   5. OPERATIONS

6. PATTERNS
7. ROUTINES
C. NUMERIC CONTROL LABORATORY
1. PROCESSOR OPERATION
2. TOOL OPERATION

1967 SUMMER INSTITUTE
SUBJECT MATERIAL FOR THE COORDINATE GEOMETRY LANGUAGE

I PURPOSE

II COORDINATE TABLE

III ACCURACY

IV CODING INSTRUCTIONS

- A. COMMAND NAME
- B. DATA
- C. DITTO FEATURE
- D. COMMENTS

V LANGUAGE CONVENTIONS

- A. ANGLES AND AZIMUTHS
- B. BEARINGS
- C. MEASUREMENT OF ANGLES

VI NON-COMPUTATIONAL INSTRUCTIONS

- A. CLEAR
- B. STORE
- C. DUMP
- D. PAUSE

VII INSTRUCTIONS

- A. LOCATE
- B. INVERSE
- C. ANGLE
- D. DISTANCE
- E. PARALLEL/LINE
- F. INTERSECT
- G. AREA
  - 1. POLYGON
  - 2. SEGMENTS

VIII TRIANGULATION

IX TRAVERSE ADJUSTMENT

X ARC

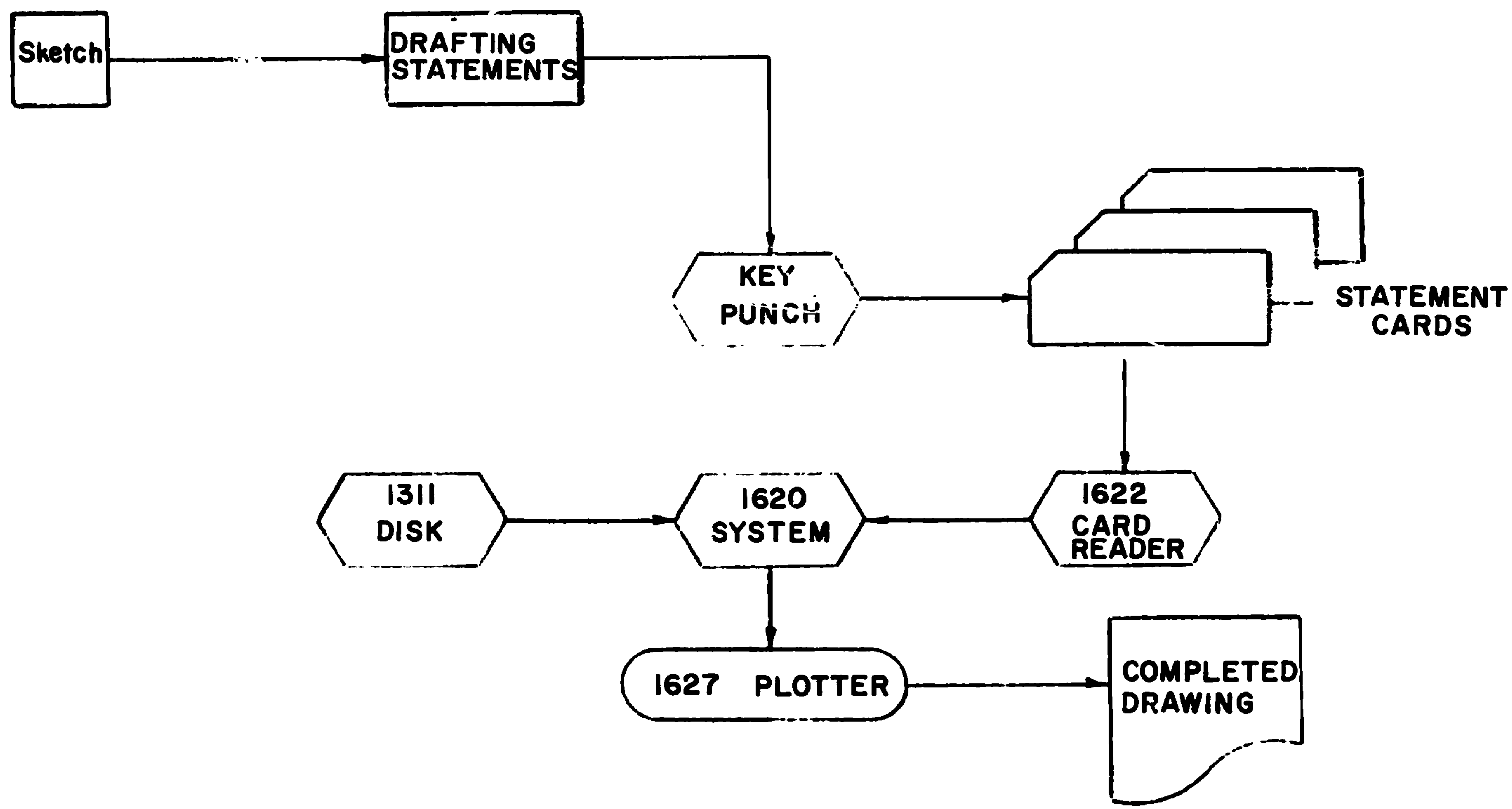
XI TANGENT

XII CURVES

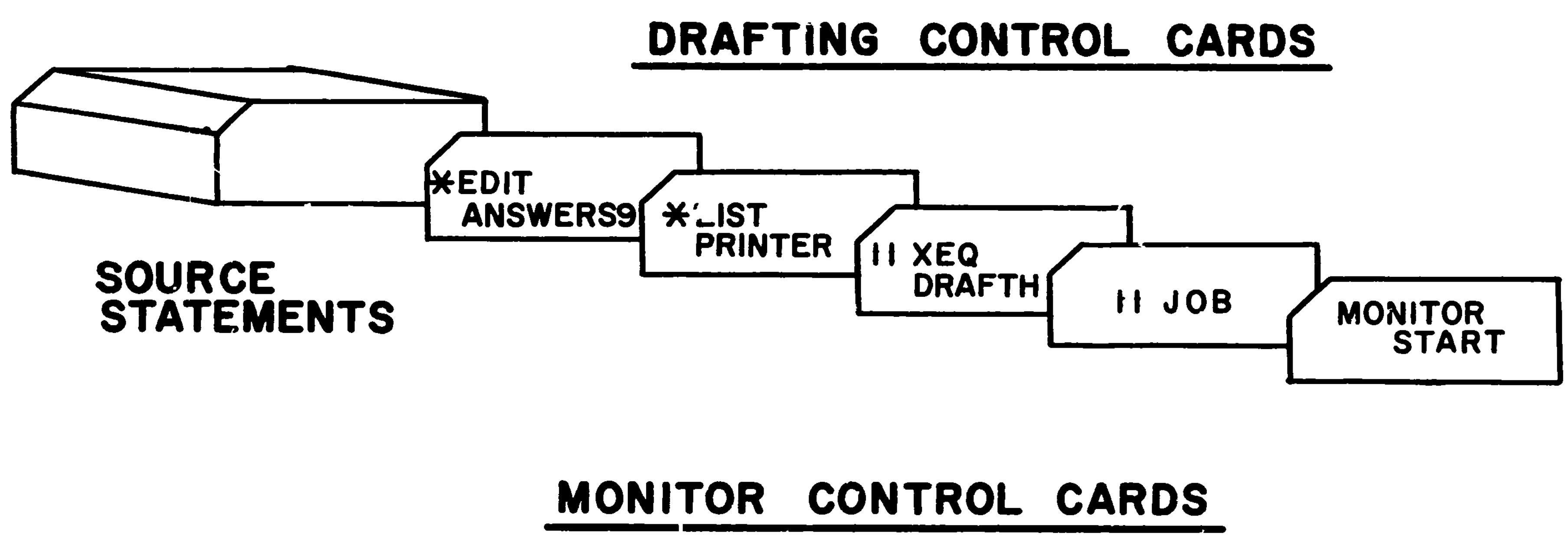
- A. ALIGNMENT
- B. OFFSETS

XIII DIVIDING LINE

XIV GIRDER LENGTHS



PROCEDURE FOR PRODUCING A DRAWING



STACKED JOB INPUT

DRAFTING LANGUAGE

1967 SUMMER INSTITUTE
MIAMI-DADE JUNIOR COLLEGE
DRAFTING LANGUAGE

Exercise 1

Draw Sketch 1 using the following specifications:

1. Paper Size 8½ x 11,
2. Thick border ½ inch from the paper edge except on the left which shall have a 1½ inch border,
3. A 3/4 inch title block on the bottom with the note 'INTRODUCTION TO LINES',
4. Place the note, 'PLATE 1' in the lower right corner above the title block,
5. When writing the program use the mirror geometric function,
6. Place the Part Origin at 4.75 and 6.00.

Exercise 2

Draw Sketch 2 using the paper size and border as given in Exercise 1 and include the following specifications:

1. In the title block write the note, 'INTRODUCTION TO CIRCLES',
2. Write the note, 'PLATE 2'

Exercise 3

Exercise 3 is a demonstration of writing notes using the Drafting Language.

Exercise 4

Draw Sketch 4 using the paper size and border as given in Exercise 1 and include the following specifications:

1. Scale = 2,
2. Title, 'PICTURE AND FRAME'.

Exercise 5

Draw Sketch 5 using the paper size and border as given in Exercise 1 and include the following specifications:

1. The paper and part origin are at the same point,
2. Draw the plate so that the part is along the X-axis,
3. Do not draw the slot,
4. Note that distance KA is unknown,
5. Title, 'SHEAR PLATE'.

Exercise 6

Draw Sketch 6 using the paper size and border as given in Exercise 1 and include the following specifications:

1. Scale = 3/4
2. Origin, 4.75, 6,
3. Draw the object lines of the base only,
4. Title, 'FIXTURE BASE'.

Exercise 7

Draw Sketch 7 as a Macro for a 8½ x 11 sheet of paper using the following specifications:

1. The title will always be on the bottom,
2. The X axis is either the short or long dimension of the paper,
3. The border is a thick line.

NOTE: ALL EXERCISES SHALL BE DRAWN USING THIS MACRO.

Exercise 8

Draw Sketch 8 using the Macro developed in Exercise 7 using the following specifications:

1. Scale = 2,
2. Origin, 2.5, 4, lower left corner of part;
3. Dimension all object lines and notice that one line has an unknown dimension.

Exercise 9

Use Plate 5 as a base and add the following specifications to draw Plate 9:

1. Draw the slot and center lines,
2. Dimension the arcs KJH, JHG, HGF and GFE.

Exercise 10

Use Plate 6 as a base and add the following specifications to draw Plate 10:

1. Draw the slot and center lines,
2. Draw the circles,
3. Dimension the slot width and height,
4. Dimension the base height and vertical dimension between large circles.

Exercise 11

Draw Sketch 11 using the following specifications:

1. Origin, 4.75, 6 at center of gasket,
2. Dimension one of the six holes, the 7/8" radius,
3. Dimension the angles between the three holes at the bottom.

Exercise 12

Draw Sketch 12 using the following specifications:

1. Use the EDIT ANSWERS9 control card to determine the unknown distance,
2. Use the COSD and SIND arithmetic functions for solving the unknown height,
3. Side view origin, 2.25, 2.25, lower left corner,
4. Front view origin 17., 2.25, lower left corner,
5. Draw the plate so that the part is along the X-axis,
6. Dimension the base of the side view,
7. Dimension the X-component of the slot and dove-tail slot of the front view.

Exercise 13

Draw Sketch 13 using the following specifications:

1. Top view origin, 2.312 + 11/8, 8., center of circle,
2. Front view origin, 4.687 + 11/8, 4.125, center of circle,
3. Dimension the X-component of the top arc and hidden lines,
4. Dimension the height in both views.

Exercise 14

Draw Sketch 14 using the following specifications:

1. Scale = .5,
2. Origin, 6.25, 5.5, center of large circle,
3. Dimension the object lines of the side view,
4. Dimension the distance between the circle centers in the front view.

Exercise 15

Draw Sketch 15 using the following specifications:

1. Scale = .5
2. Front view origin, 4.50, 3 11/16,
3. Dimension the following dimensions on the front view; 9/16" vertical, 1 3/8", 1 7/8", and 1 1/8",
4. NOTER Statement in top view Arcs in this slot are 3/8", and the distance between centers is 1.5".

Exercise 16

Draw Sketch 16 using the following specifications:

1. Top view origin, 3.00, 2.1875, low left corner,
2. Side view origin, 7 13/16, 3 3/4, center of circle,
3. Dimension 7/16" on side view,
4. NOTE Statement in top view, "9/32 Drill, CSK 82° x 1/2 DIA.", with the letters at an angle of -15°,
5. NOTER Statements in side view, "1/4 Drill, Bore 1/2 DIA. x 1 7/8 DP" and "5/8 R",
6. Note Statement for Finish Mark,
7. Draws part parallel to X-axis.

Exercise 17

Draw Sketch 17 using the following specifications:

1. Top view origin, 3.75, 5.875, center of cap, all views,
2. Draw cutting plane in top view and section view with hatching,
3. Dimension 2" and 11/16" in section view.

Exercise 18

Draw Sketch 18 using the following specifications:

1. Top view origin, 4.25, 3.75, center of shaft guide,
2. Draw cutting plans in top view and section view with hatching.

Exercise 19

Demonstration

Exercise 20

Draw Sketch 20 using the following specifications:

1. Write a macro to draw the coordinate axis with the following parameters;

   A. Length of X-axis,
   B. Length of Y-axis,
   C. Scale for the X-axis,
   D. Scale for the Y-axis,

2. Write a macro to draw a bar graph with the following parameters:
   A. Center of the bar on the X-axis,
   B. Bar width and height,
   C. Type of latching,
   D. Y value as a literal,
   E. Front of the literal,
   F. Number of letters in the literal.

Exercise 21

Draw Sketch 21 using the following specifications:

1. Origin, 8.70, 6.5, same origin as shown on the sketch,
2. Dimension the arc centers of the depressions and the length of the part.

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NUMERICAL CONTROL

Exercise 1

Write a program in machine language for the Pratt-Whitney Tape-o-matic Drilling and Boring Machine to drill the holes as shown in the Autospot Sketch.

Exercise 2

Create the paper tape for the program written in Exercise 1 and execute the program on the Pratt-Whitney Tape-o-matic Drilling and Boring Machine.

Exercise 3

Write a program in Autospot II Language and create the paper tape to drill the holes shown in the Autospot Sketch.

IDED BY B.L.D. DATE July 1967 SHEET 1 OF 1

11/01/80

1620 DRAFTING SYSTEM

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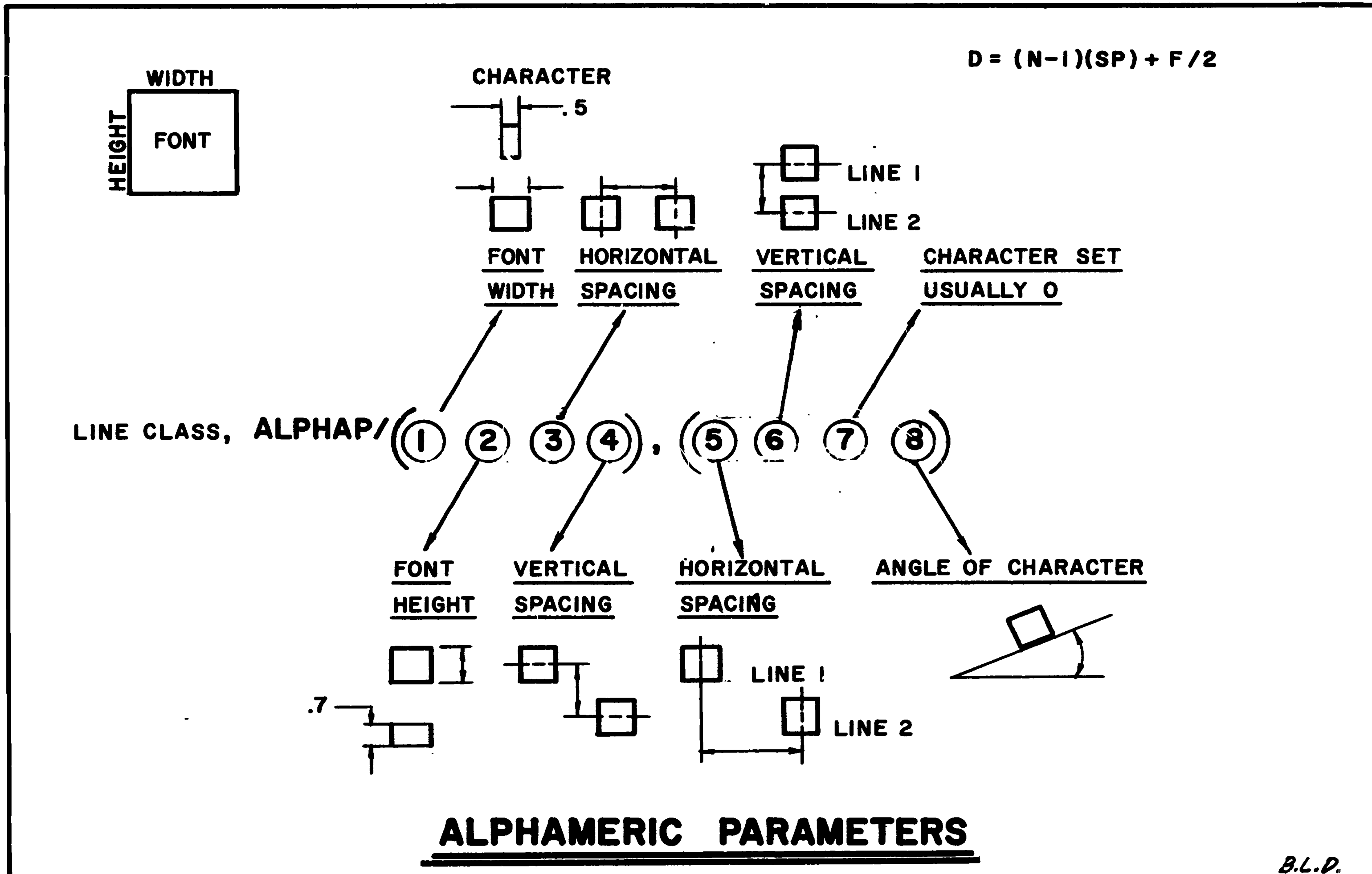
$|$ FOR COMMENT

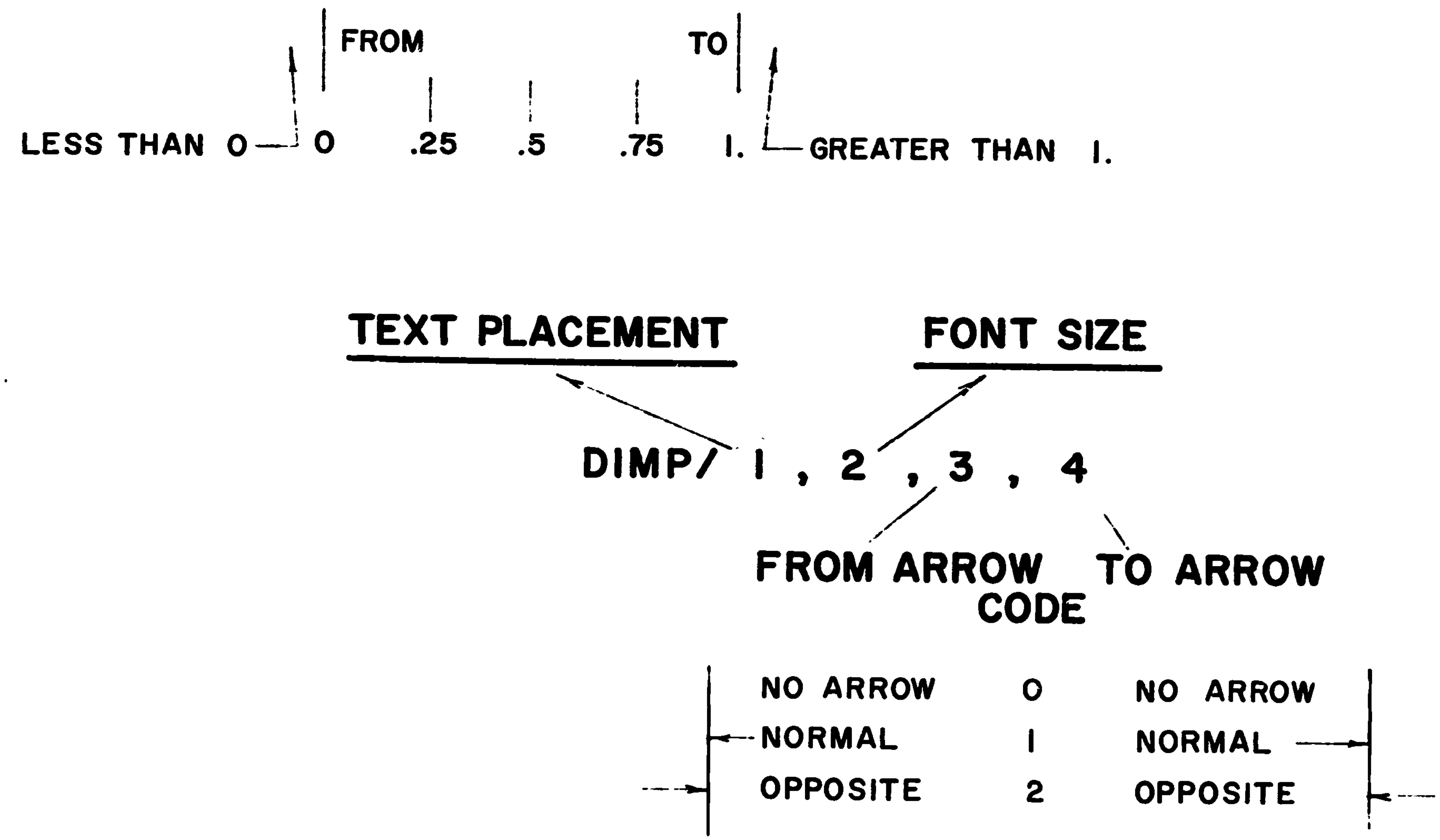
IDENTIFICATION 77 80

STA. NO.	LABEL	=	LINE CLASS	,	MAJOR WORD	PHRASE	SEQ.

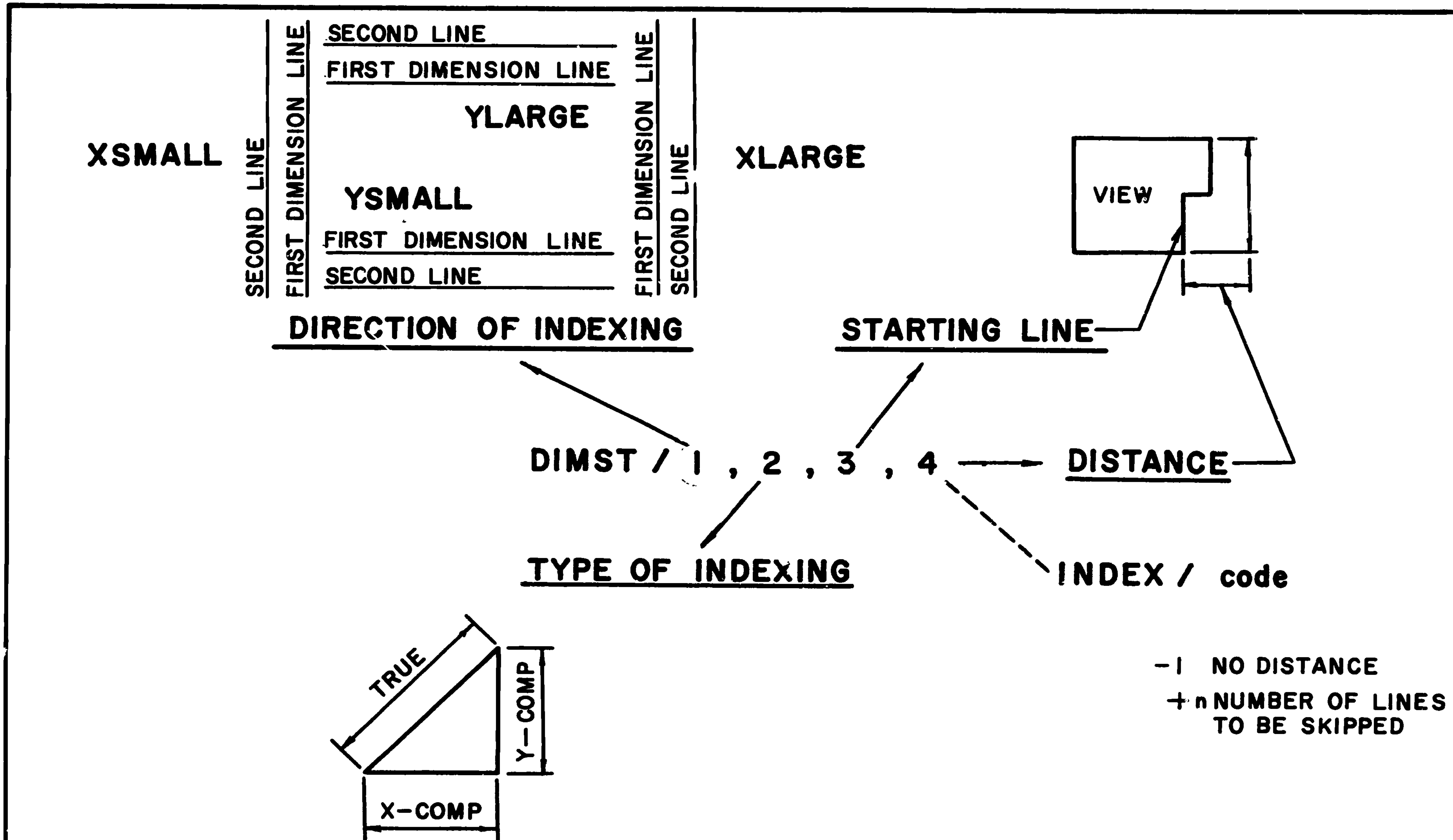
```
  ALABEL =             /AN EXAMPLE OF A LABEL
  A12345 =             /FIRST LETTER MUST BE A LETTER (A-Z)
  A      =             /LABELS ARE 1-6 CHARACTERS IN LENGTH

         CTRLN ,        AN EXAMPLE OF A LINE CLASS

                 LINE  /AN EXAMPLE OF A MAJOR WORD

                 POINT /-123456.78,1  AN EXAMPLE OF NUMBERS
                            NUMBERS CAN BE UP TO 8 DIGITS
                            THE DECIMAL POINT IS OPTIONAL
                            NEGATIVE NUMBERS MUST BE SIGNED
                        @A LITERAL@ 1-48 CHARACTERS
                                  @ NOT PART OF LITERAL
$$  USED TO PLACE COMMENTS AMONG THE PROGRAM STATEMENTS
1)                      AN EXAMPLE OF A NUMBERED STATEMENT
                 A R C / BLANKS ARE IGNORED BY THE PROCESSOR
```

THIS FORM IS FOR PROGRAMMING CONVENIENCE - THE DRAFTING LANGUAGE MAY BE WRITTEN IN FREE FORMAT.

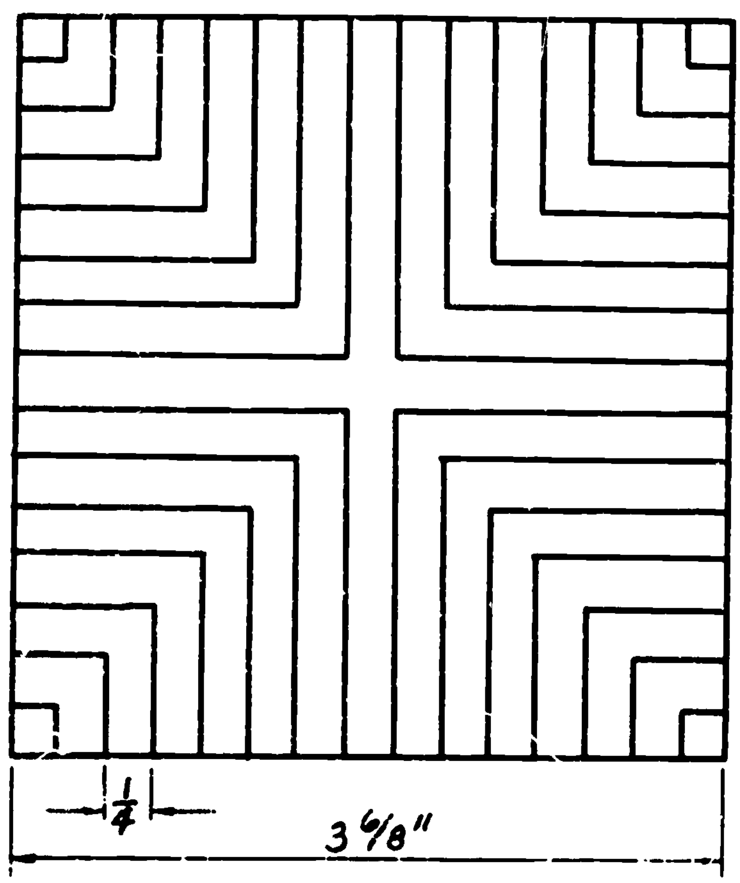

D = (N-1)(SP) + F/2
WIDTH
HEIGHT
FONT
CHARACTER
.5
LINE 1
LINE 2
FONT WIDTH
HORIZONTAL SPACING
VERTICAL SPACING
CHARACTER SET USUALLY 0
LINE CLASS, ALPHAP/((1) (2) (3) (4)), ((5) (6) (7) (8))
FONT HEIGHT
VERTICAL SPACING
HORIZONTAL SPACING
ANGLE OF CHARACTER
.7
LINE 1
LINE 2
ALPHAMERIC PARAMETERS
B.L.D.



DIMP STATEMENT



DIMST AND INDEX STATEMENTS



SKETCH 1

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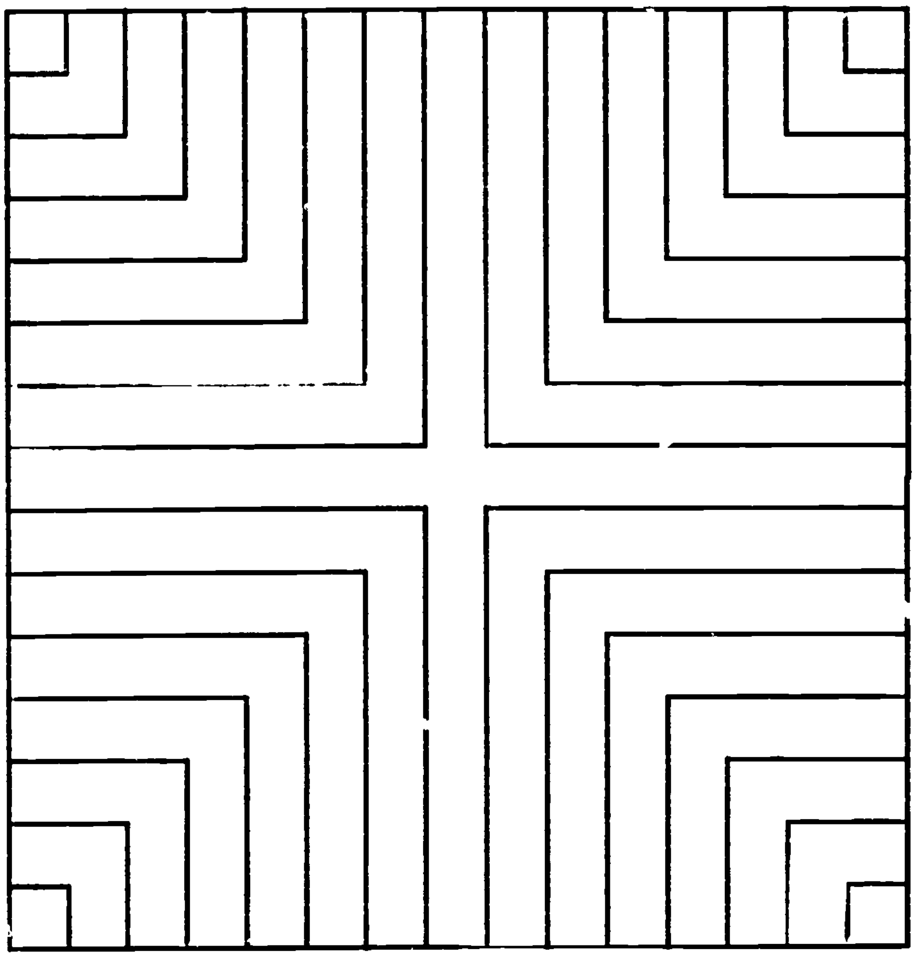

PLATE 1

INTRODUCTION TO LINES

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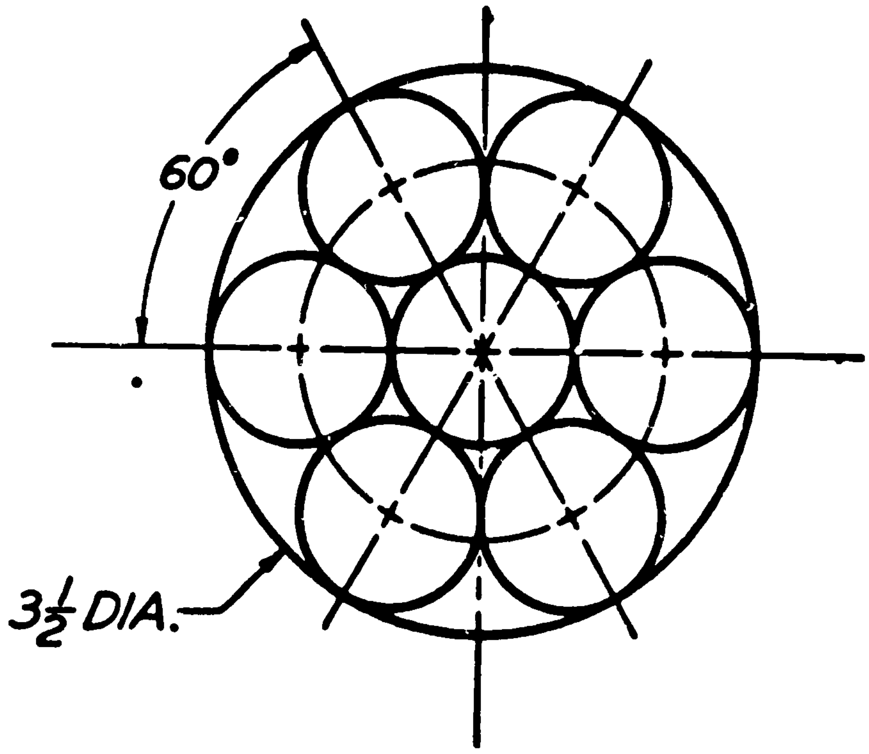
```
$$  PLATE 1          INTRODUCTION TO LINES
  BOX      =THICK ,VIEW  /
                   LINE  /1.5,.5,DX,6.5
                   LINE  /DY,10
                   LINE  /DX,-6.5
                   LINE  /DY,-10
                   LINE  /1.5,1.25,DX,6.5
                   END   /BOX
                   DRAW  /BOX
                   ALPHAP/(.2,.3,.282,0),(0,0,0,0)
                   TITLE/1.6,.875,@ INTRODUCTION TO LINES@
                   TITLE /6,1.5,@PLATE  1@
  SQUARE =         VIEW  /
                   ORIGIN/4.75,6
                   LINE  /1+7/8,0,DY,1+7/8
                   LINE  /DX,-1-7/8
                   LINE  /1/8,1+7/8,DY,-1-3/4
                   LINE  /DX,1+3/4
                   LINE  /1+7/8,3/8,DX,-1-1/2
                   LINE  /DY,1+1/2
                   LINE  /5/8,1+7/8,DY,-1-1/4
                   LINE  /DX,1+1/4
                   LINE  /1+7/8,7/8,DX,-1
                   LINE  /DY,1
                   LINE  /1+1/8,1+7/8,DY,-3/4
                   LINE  /DX,3/4
                   LINE  /1+7/8,1+3/8,DX,-1/2
                   LINE  /DY,1/2
                   LINE  /1+5/8,1+7/8,DY,-1/4
                   LINE  /DX,1/4
                   END   /SQUARE
                   DRAW  /SQUARE
                   DRAW  /MIRX(SQUARE)
                   DRAW  /MIRY(SQUARE)
                   DRAW  /MIRXY(SQUARE)
                   FINI  /
```



SKETCH 2

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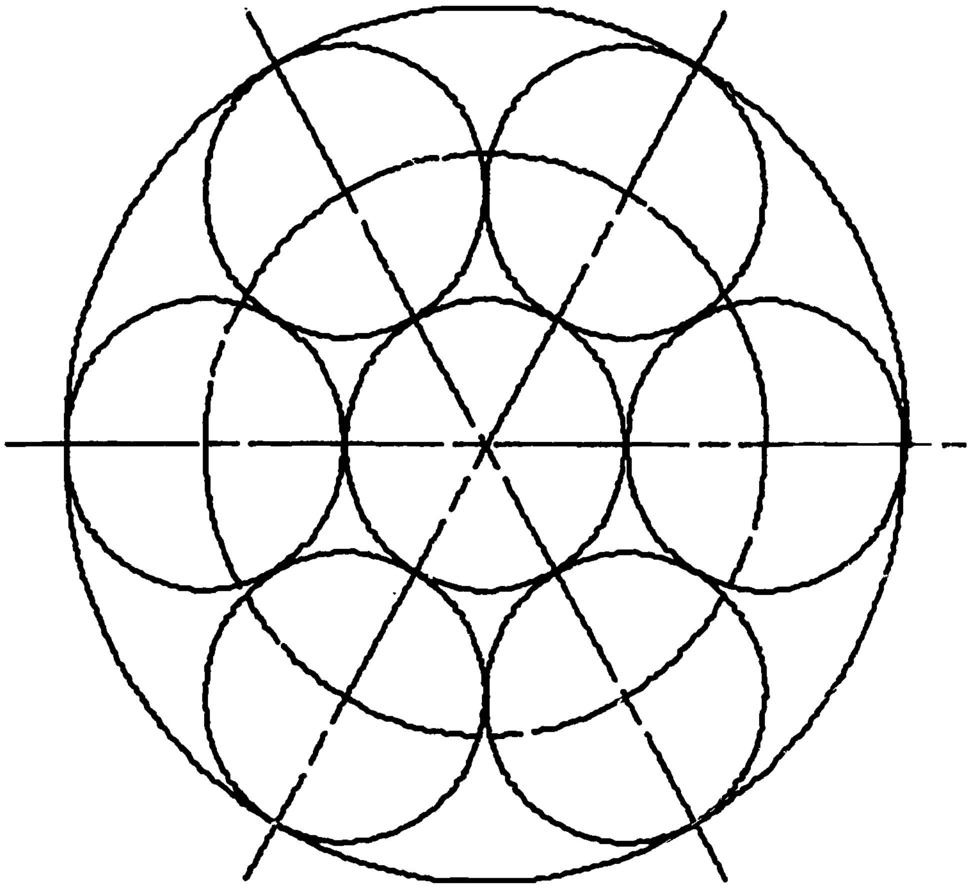

PLATE 2

INTRODUCTION TO CIRCLES

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```
$$  PLATE 2          INTRODUCTION TO CIRCLES
 BOX      =THICK ,VIEW  /
                  LINE  /1.5,.5,DX,6.5
                  LINE  /DY,10
                  LINE  /DX,-6.5
                  LINE  /DY,-10
                  LINE  /1.5,1.25,DX,6.5
                  END   /BOX
                  DRAW  /BOX
                  ALPHAP/(.2,.3,.26,0),(0,0,0,0)
                  TITLE/1.6,.875,@ INTRODUCTION TO CIRCLES@
                  ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                  TITLE /6,1.5,@PLATE  2@
 DESIGN   =       VIEW  /
                  ORIGIN/4.75,6
                  CIRCLE/0,0,1.75
 C1       =CTRLN ,CIRCLE/0,0,1.166
 L1       =CTRLN ,LINE  /-2,0,DX,4
           CONSTR,LINE  /0,0,ATANGL,120,LENGTH,2
 L2       =CTRLN ,LINE  /PPP,ATANGL,300,LENGTH,4
           CONSTR,LINE  /0,0,ATANGL,60,LENGTH,2
 L3       =CTRLN ,LINE  /PPP,ATANGL,240,LENGTH,4
                  CIRCLE/(POINT/XSMALL,INTOF,L1,C1),1.166/2
                  CIRCLE/(POINT/YLARGE,INTOF,L2,C1),1.166/2
                  CIRCLE/(POINT/YLARGE,INTOF,L3,C1),1.166/2
                  CIRCLE/1.166,0,1.166/2
                  CIRCLE/(POINT/YSMALL,INTOF,L2,C1),1.166/2
                  CIRCLE/(POINT/YSMALL,INTOF,L3,C1),1.166/2
                  CIRCLE/0,0,1.166/2
                  END   /DESIGN
                  DRAW  /DESIGN
                  FINI  /
```

ABCDEFG A B C D E F G

(.3,.3,.3,0),(0,0,0,0) (.3,.3,.5,0),(0,0,0,0)

ABCDEFG

(.3,.3,.18,0),(0,0,0,0)

A B C D E F G G F E D C B A

(.3,.3,.3,.2),(0,0,0,0)

(.3,.3,.3,-.2),(0,0,0,0)

ABCDEFG

(.1,.3,.1,0),
(0,0,0,0)

A B C D E F G

(.3,.1,.3,0),(0,0,0,0)

A B C D E F

(.6,.6,.6,0),(0,0,0,0)

ABCDE
FGHIJ
KLMNO

(.3,.3,.3,0),(.3,-.3,0,0)

ABCDE

FGHIJ

(.3,.3,.3,0),(0,-.6,0,0)

NOTES CAN BE
DRAWN WITH
AN ARROW ON
THE RIGHT

OR THEY CAN
BE DRAWN WITH
AN ARROW ON
THE LEFT

(.2,.2,.2,0),(0,0,0,0)

PLATE 3

INTRODUCTION TO NOTES

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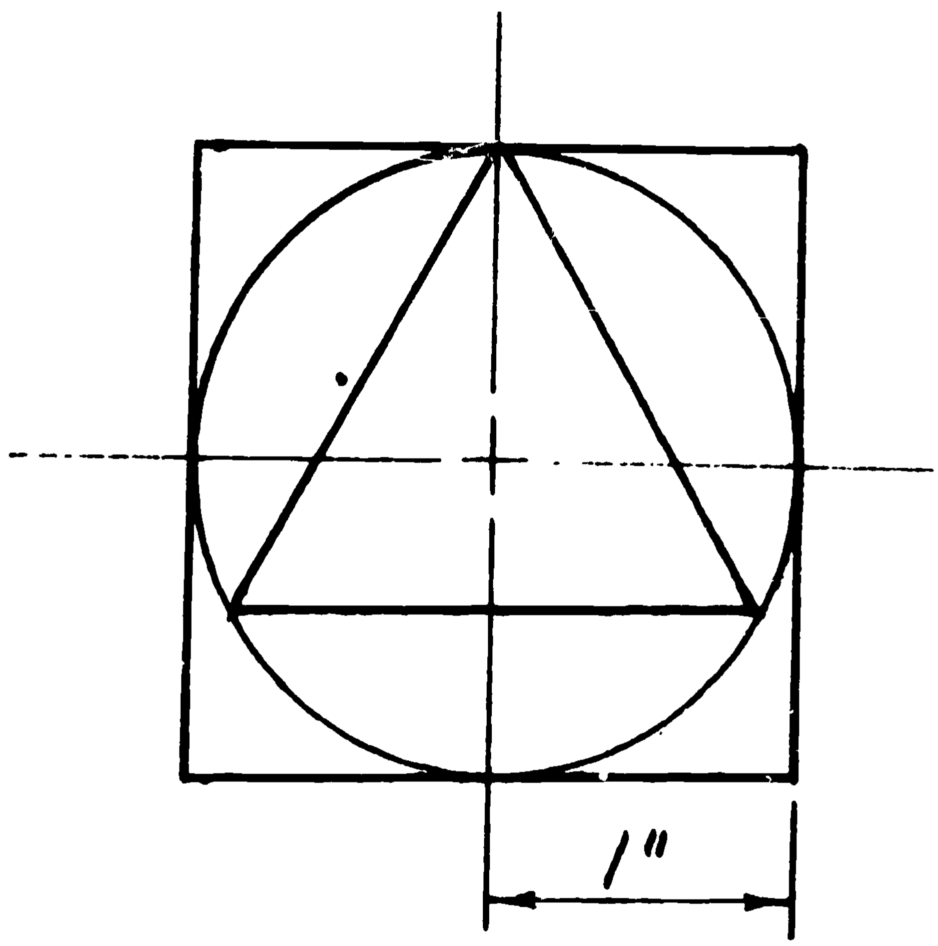
```
$$  PLATE 3           INTRODUCTION TO NOTES
 BOX      =THICK ,VIEW  /
                   LN     /1.5,.5,DX,6.5
                   LN     /DY,10
                   LN     /DX,-6.5
                   LN     /DY,-10
                   LN     /1.5,1.25,DX,6.5
                   END    /BOX
                   DRAW   /BOX
                   ALPHAP/(.2,.3,.282,0),(0,0,0,0)
                   TITLE /1.5,.875,@ INTRODUCTION TO NOTES@
                   ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                   TITLE/6,1.5,@PLATE  3@
                   ORIGIN/.39,-.225
                   ALPHAP/(.3,.3,.3,0),(0,0,0,0)
                   NOTE  /1.65,10,@ABCDEFG@
                   ALPHAP/(.3,.3,.5,0),(0,0,0,0)
                   NOTE  /4.2,10,@ABCDEFG@
                   NOTE  /2.05,8.8,@ABCDEFG@
                   ALPHAP/(.3,.3,.3,.2),(0,0,0,0)
                   NOTE  /3.3,7.6,@ABCDEFG@
                   ALPHAP/(.3,.3,.3,-.2),(0,0,0,0)
                   NOTE  /5.4,8.8,@GFEDCBA@
                   ALPHAP/(.1,.3,.1,0),(0,0,0,0)
                   NOTE  /1.65,7.6,@ABCDEFG@
                   ALPHAP/(.3,.1,.3,0),(0,0,0,0)
                   NOTE  /1.65,6.4,@ABCDEFG@
                   ALPHAP/(.6,.6,.6,0),(0,0,0,0)
                   NOTE  /4.2,6.4,@ABCDEF@
                   ALPHAP/(.3,.3,.3,0),(.3,-.3,0,0)
                   NOTE  /1.65,5.2,@ABCDE@,@FGHIJ@,@KLMNO@
                   ALPHAP/(.3,.3,.3,0),(0,-.6,0,0)
                   NOTE  /5.0,5.2,@ABCDE@,@FGHIJ@
                   ALPHAP/(.2,.2,.2,0),(0,-.2,0,0)
                   NOTER /4.25,2.8,-.35,.55,@NOTES CAN BE@,$
                   NOTE  /4.25,2.8,.45,.55,@OR THEY CAN@,$
                   @BE DRAWN WITH@,@AN ARROW ON@,@THE LEFT@
                   ALPHAP/(.1,.1,.1,0),(0,0,0,0)
                   NOTE  /1.49,9.75,@(.3,.3,.3,0),(0,0,0,0)@
                   NOTE  /4.65,9.75,@(.3,.3,.5,0),(0,0,0,0)@
                   NOTE  /1.5,8.55,@(.3,.3,.18,0),(0,0,0,0)@
                   NOTE  /4.15,7.8,@(.3,.3,.3,.2),(0,0,0,0)@
                   NOTE  /4.15,7.55,@(.3,.3,.3,-.2),(0,0,0,0)@
                   NOTE  /1.5,7.35,@(.1,.3,.1,0),@
                   NOTE  /1.5,7.25,@(0,0,0,0)@
                   NOTE  /4.7,6.15,@(.6,.6,.6,0),(0,0,0,0)@
                   NOTE  /1.5,6.15,@(.3,.1,.3,0),(0,0,0,0)@
                   NOTE  /1.5,4.35,@(.3,.3,.3,0),(.3,-.3,0,0)@
                   NOTE  /4.5,4.35,@(.3,.3,.3,0),(0,-.6,0,0)@
                   NOTE  /3.15,2.55,@(.2,.2,.2,0),(0,0,0,0)
                   FINI  /
```



SKETCH 4

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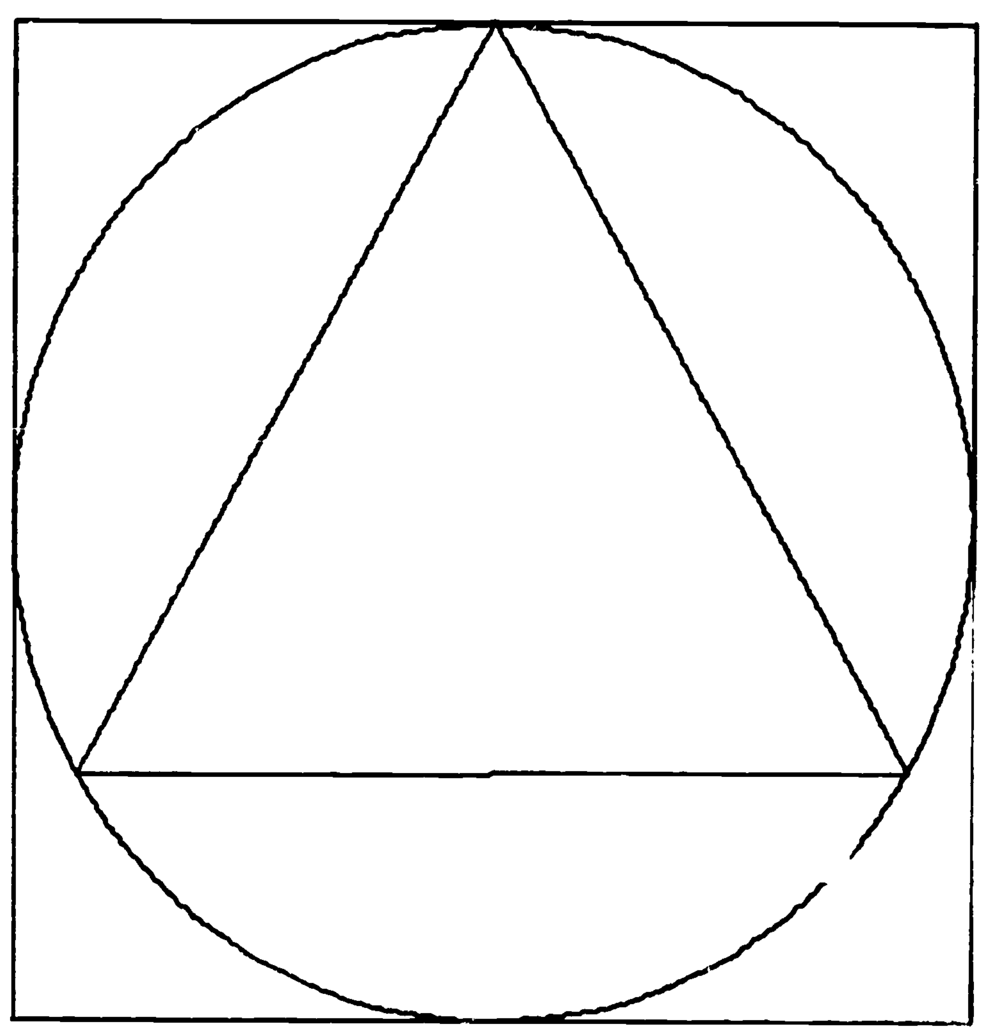

PLATE 4

PICTURE AND FRAME

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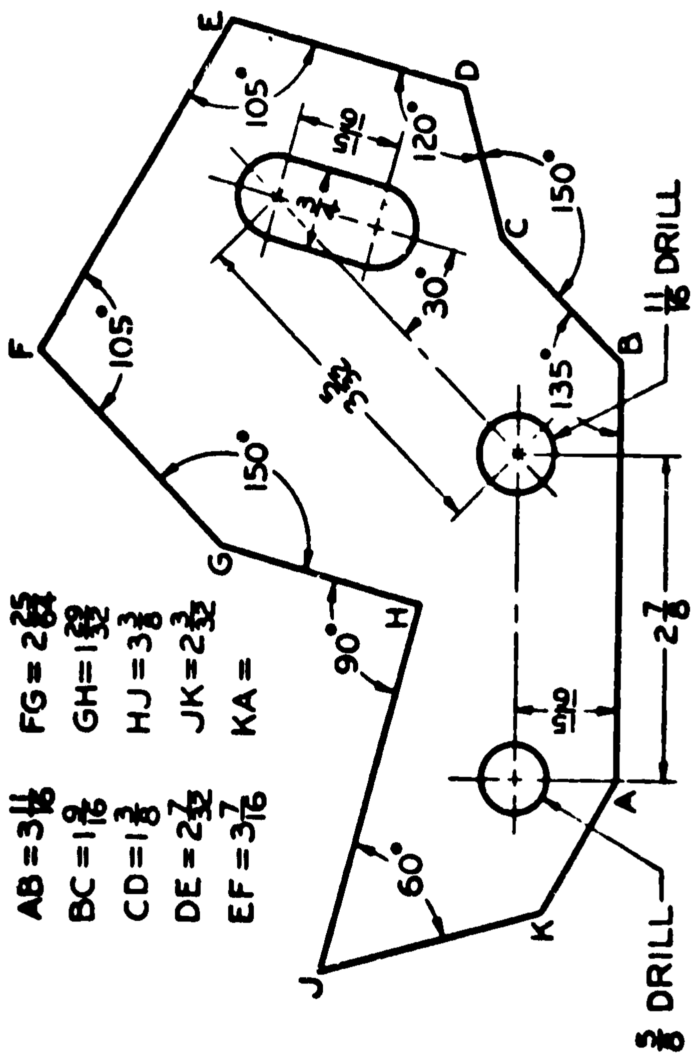
```
$$ PLATE 4          SQUARE INSCRIBED IN A CIRCLE
  BOX      =THICK ,VIEW  /
                   LN     /1.5,.5,DX,6.5
                   LN     /DY,10
                   LN     /DX,-6.5
                   LN     /DY,-10
                   LN     /1.5,1.25,DX,6.5
                   END    /BOX
                   DRAW   /BOX
                   ALPHAP/(.3,.3,.3,0),(0,0,0,0)
                   TITLE /2.05,.875,@ PICTURE AND FRAME@
                   ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                   TITLE /6,1.5,@PLATE  4@
  PICT     =       VIEW  /
                   ORIGIN/4.75,6
                   SCALE /2
                   LN     /-1,-1,DX,2
                   LN     /DY,2
                   LN     /DX,-2
                   LN     /DY,-2
                   CIRCLE/0,0,1
  P1       =       PT     /0,0,ATANGL,90,LENGTH,1
  P2       =       PT     /0,0,ATANGL,210,LENGTH,1
  P3       =       PT     /0,0,ATANGL,330,LENGTH,1
                   LN     /P1,P2
                   LN     /P2,P3
                   LN     /P3,P1
                   END    /PICT
                   DRAW   /PICT
                   FINI  /
```



SKETCH 5

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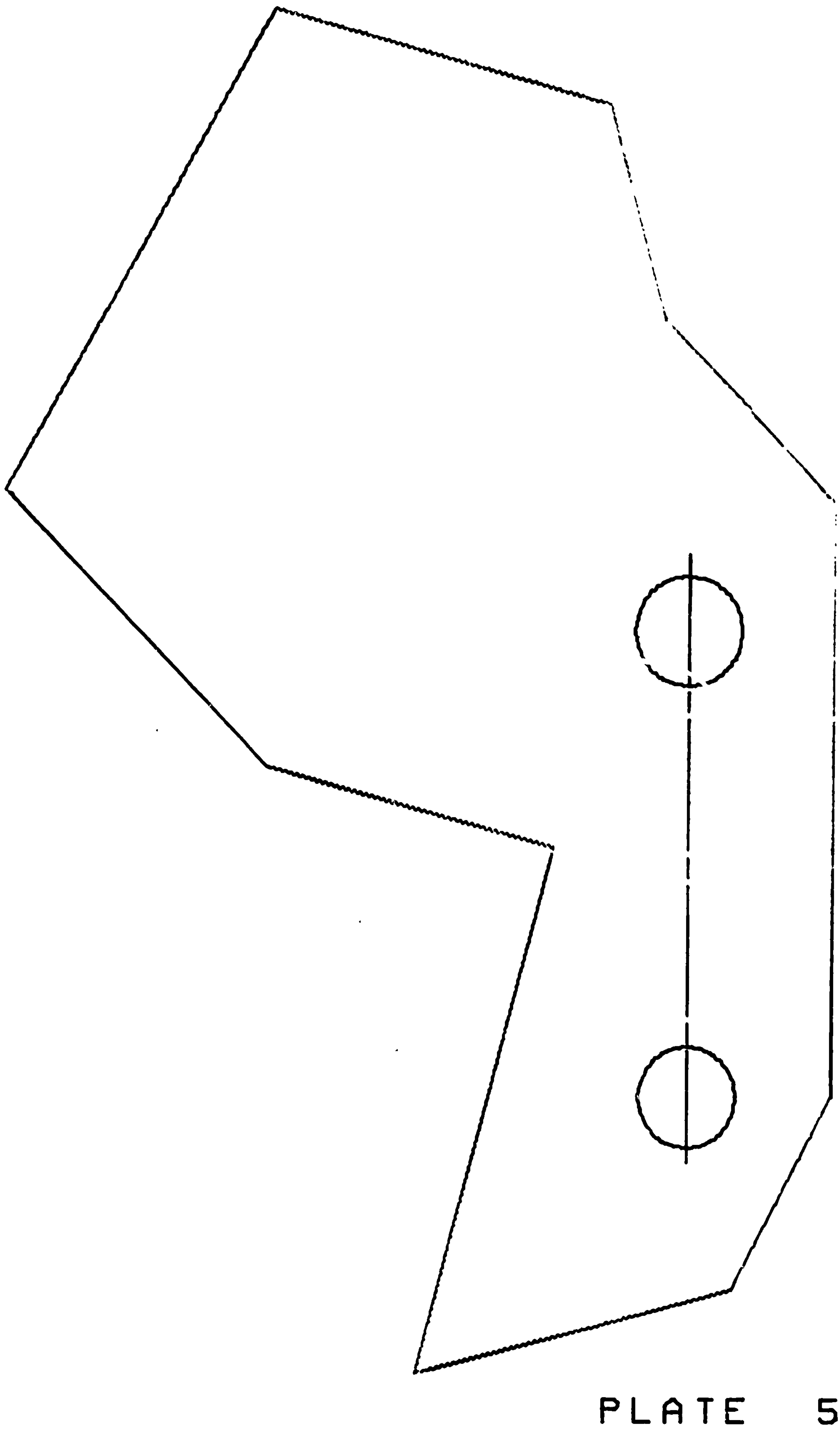

PLATE 5

SHEAR PLATE

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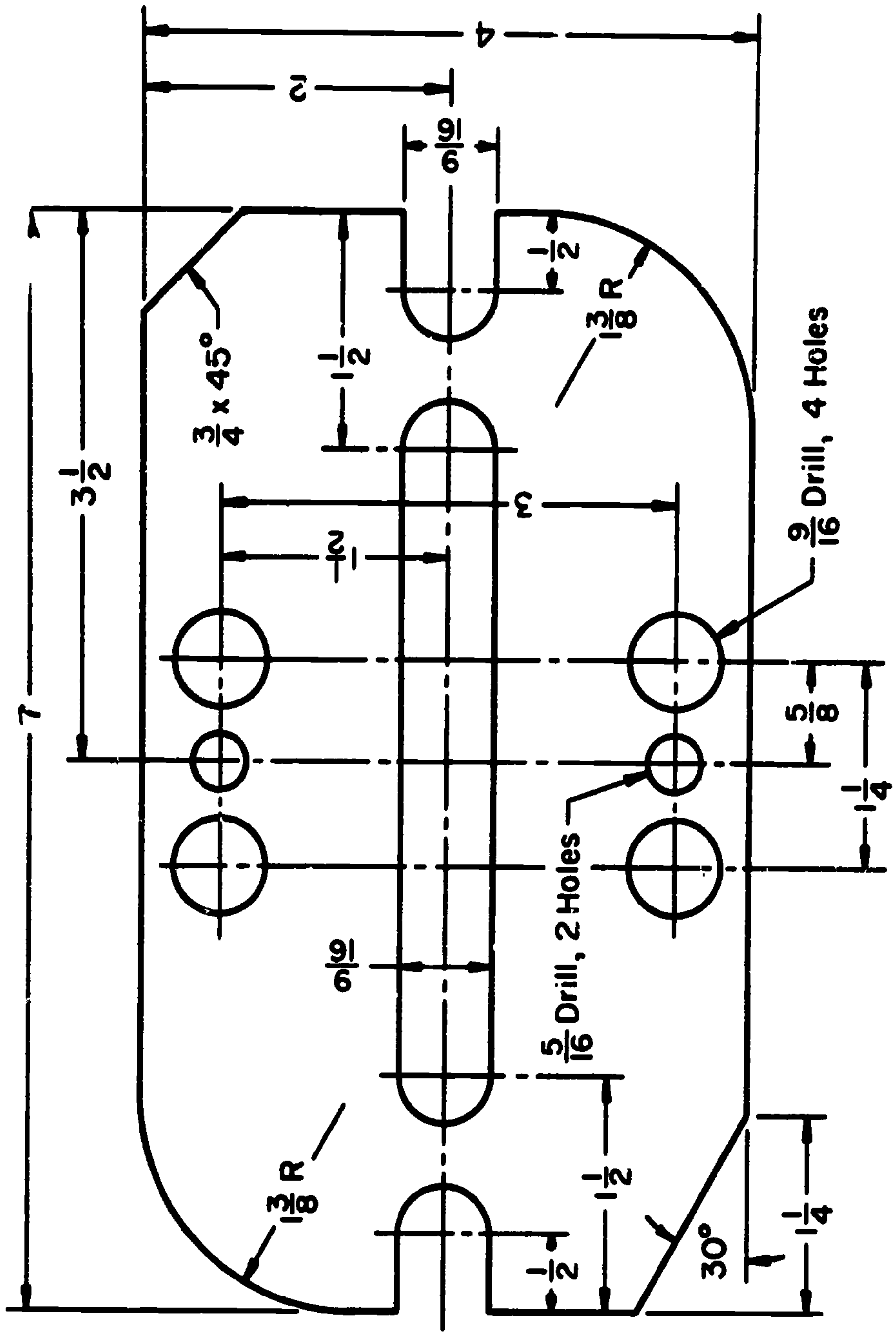
```
$$ PLATE 5           LINES AT ANGLES TO PART AXIS-SHEAR PLATE  LONG X
 BOX  =THICK,       VIEW/
                    LN     /.5,.5,DX,10
                    LN     /DY,6.5
                    LN     /DX,-10
                    LN     /DY,-6.5
                    LN     /1.25,.5,DY,6.5
                    END/BOX
                    DRAW/BOX
                    ALPHAP/(.5,.5,0,-.5),(0,0,0,270)
                    TITLE /.875,6.8,@ SHEAR PLATE@
                    ALPHAP/(.2,.2,0,-.2),(0,0,0,270)
                    TITLE /1.5,2.5,@PLATE  5@
 PLATE     =        VIEW  /
 A         =        POINT /3.45,1.08
                    LINE  /A,DX,3+11/16
                    LINE  /PPP,ATANGL,45,LENGTH,1+9/16
                    LINE  /PPP,ATANGL,15,LENGTH,1+3/8
                    LINE  /PPP,ATANGL,75,LENGTH,2+7/32
                    LINE  /PPP,ATANGL,150,LENGTH,3+7/16
                    LINE  /PPP,ATANGL,225,LENGTH,2+25/64
                    LINE  /PPP,ATANGL,255,LENGTH,1+29/32
                    LINE  /PPP,ATANGL,165,LENGTH,3+3/8
 P1        =        LINE  /PPP,ATANGL,285,LENGTH,2+3/32
                    LINE  /PPP,A
 KA        =              DIST((POINT/P1),A)
 P2        =        PT    /A,DY,15/16
                    CR    /P2,5/16
 P3        =        PT    /P2,DX,2+7/8
                    CR    /P3,11/32
                    PT    /DX,.125
           CTRLN,LN       /DX,-3.75
                    END   /PLATE
                    DRAW  /PLATE
                    FINI/
```



SKETCH 6

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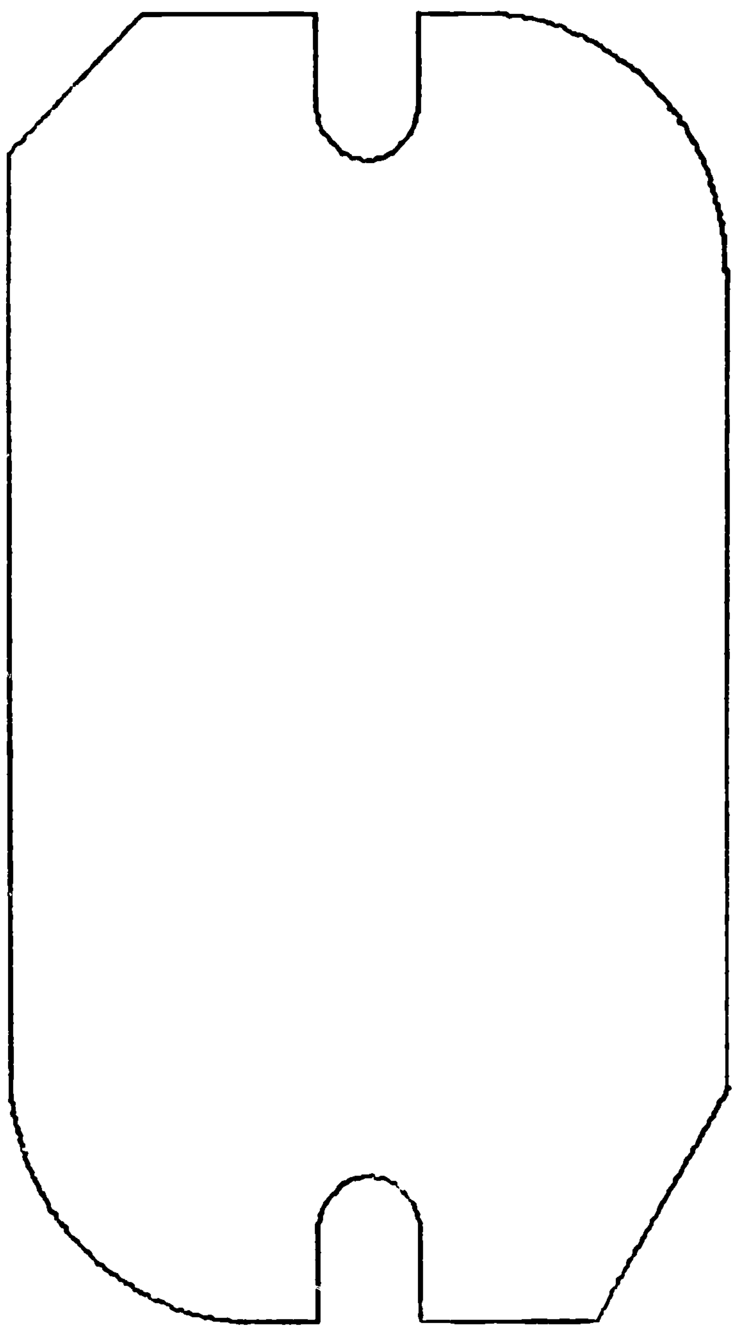

PLATE 6

FIXTURE BASE

```
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$$  PLATE 6        COMBINING ARCS AND LINES-FIXTURE BASE
  BOX     =THICK ,VIEW  /
                  LN    /1.5,.5,DX,6.5
                  LN    /DY,10
                  LN    /DX,-6.5
                  LN    /DY,-10
                  LN    /1.5,1.25,DX,6.5
                  END   /BOX
                  DRAW  /BOX
                  ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                  TITLE/5.5,1.5,@PLATE  6@
                  ALPHAP/(.4,.3,.4,0),(0,0,0,0)
                  TITLE /2.15,.875,@ FIXTURE BASE@
  BASE    =       VIEW  /
                  SCALE /3/4
                  ORIGIN/4.75,6
                  LINE  /2,-2.25,ATANGL,240,TILLY,-3.5
                  LINE  /PPP,ATANGL,180,TILLX,9/32
                  LINE  /DY,.5
                  ARC   /6,-3,9/32,0,180
                  LINE  /PPP,DY,-.5
                  LINE  /DX,-(2-9/32)
                  ARC   /1.375
                  LINE  /DY,6.25
                  LINE  /DX,3/4,DY,3/4
                  LINE  /DX,2-(3/4+9/32)
                  LINE  /DY,-.5
                  ARC   /0,3,9/32,180,180
                  LINE  /DY,.5
                  LINE  /DX,2-9/32
                  ARC   /1.375
                  LINE  /DY,-5.75
                  END   /BASE
                  DRAW  /BASE
                  FINI/
```

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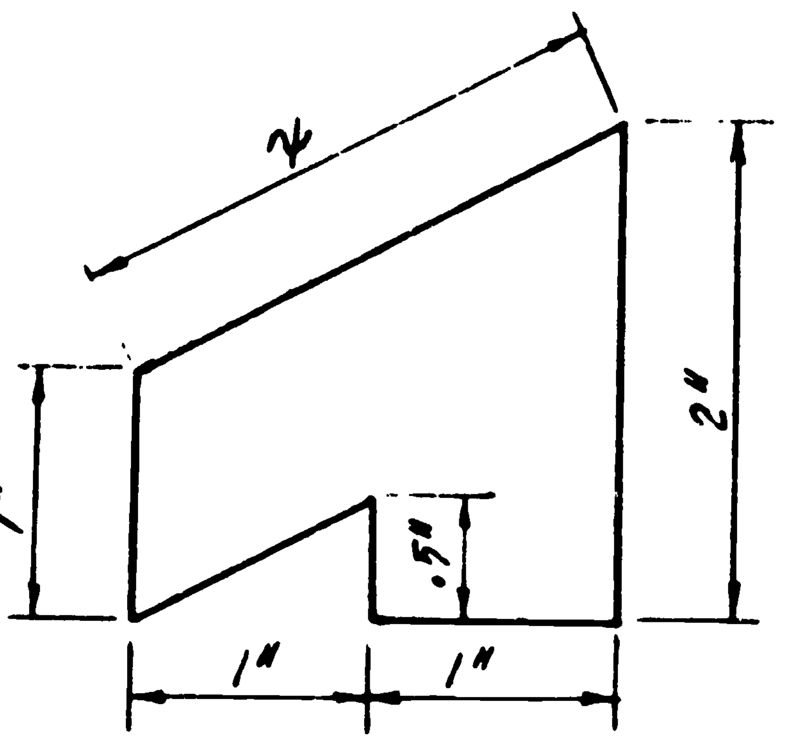

SKETCH 8

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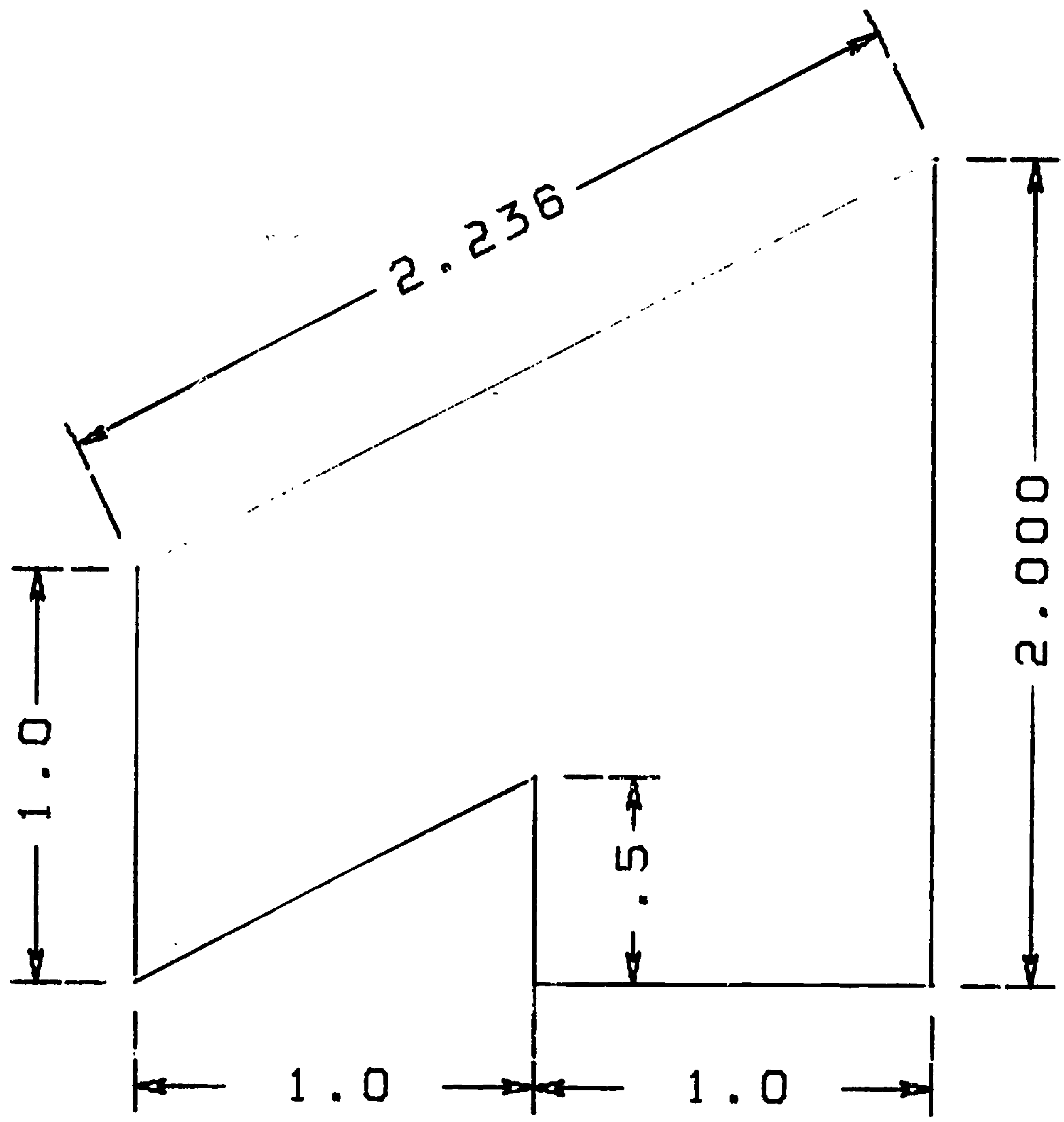

PLATE 8

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```
$$  PLATE 8         DIMENSIONING A PART
  BOX      =       VIEW /
                   CALL  /FRAME1,,X=6.5,,Y=10,,ORX=1.5,,ORY=.5
                   END  /BOX
                   DRAW  /BOX
  ABC      =       VIEW  /
                   SCALE /2
                   ORIGIN/2.5,4
  L1       =       LINE  /DY,1
  L2       =       LINE  /DX,2,DY,1
  L3       =       LINE  /DY,-2
  L4       =       LINE  /DX,-1
  L5       =       LINE  /DY,.5
  L6       =       LINE  /DX,-1,DY,-.5
                   END   /ABC
                   DRAW  /ABC
                   DIMST /XSMALL,YCOMP,L1,.5
                   MASK  /@P,D1@
                   DIM   /L1
                   DIMST /YLARGE,TRUE,L2,.5
                   MASK  /@P,D3@
                   DIMP  /.5,.2,1,1
                   DIM   /L2
                   DIMST /XLARGE,YCOMP,L3,.5
                   DIM   /L3
                   DIMST /YSMALL,XCOMP,L4,.5
                   MASK  /@H,D1@
                   DIM   /L4
                   INDEX /-1
                   DIM   /L6
                   DIMST /XLARGE,YCOMP,L5,.5
                   MASK  /@P,D1@
                   DIM   /L5
                   ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                   FINI  /
```

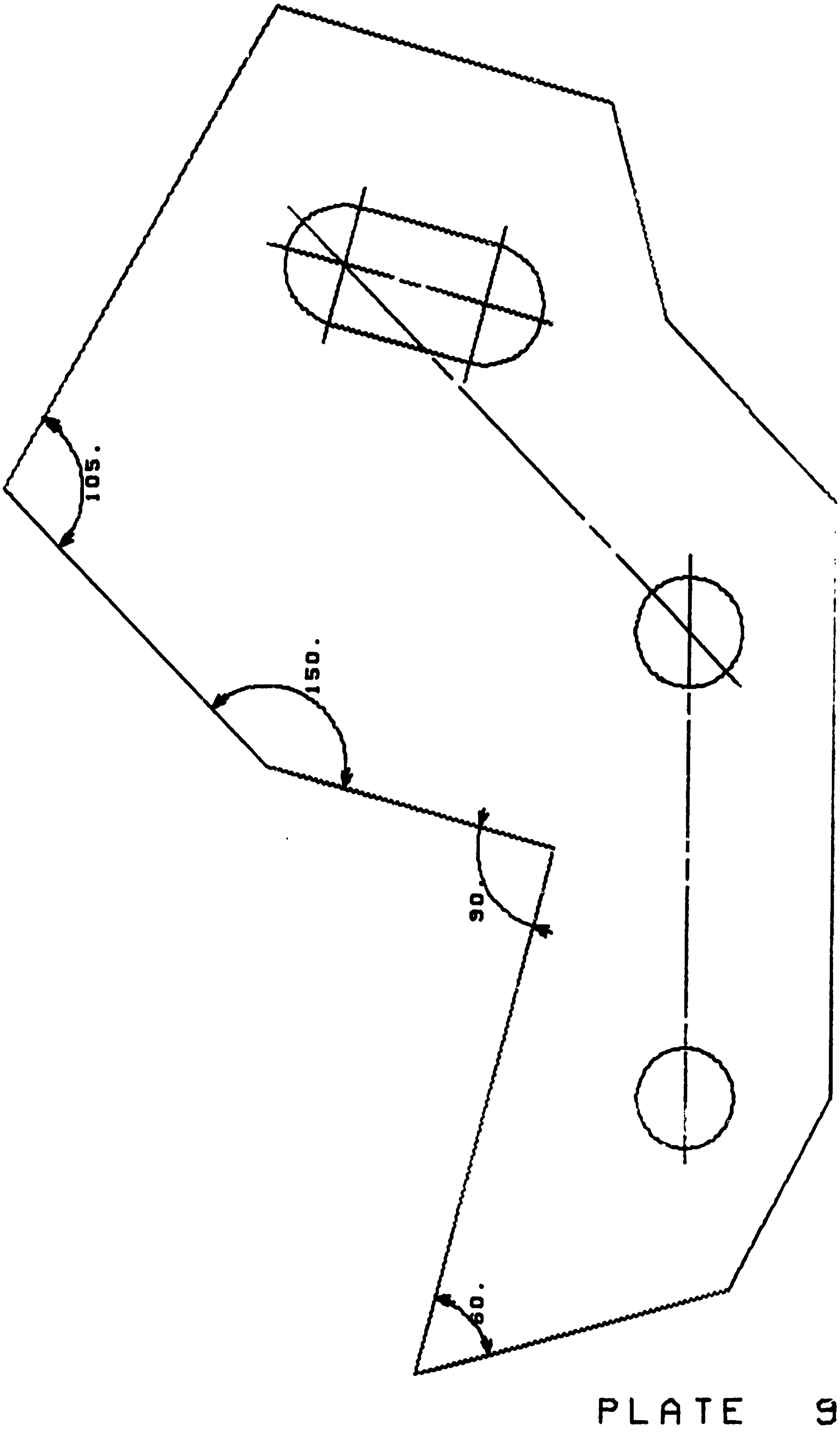

PLATE 9

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```
$$ PLATE 9            SHEAR PLATE WITH DIMENSIONS   LONG X
  BOX      =        VIEW  /
                    CALL  /FRAME1,,X=10,,Y=6.5,,ORX=.5,,ORY=.5
                    END/BOX
                    DRAW/BOX
                    ALPHAP/(.2,.2,0,-.2),(0,0,0,270)
                    TITLE /1.5,2.5,@PLATE  9@
  PLATE    =        VIEW  /
                    ORIGIN/NOMORE
  A        =        POINT /3.45,1.08
                    LINE  /A,DX,3+11/16
                    LINE  /PPP,ATANGL,45,LENGTH,1+9/16
                    LINE  /PPP,ATANGL,15,LENGTH,1+3/8
  D        =        POINT /PPP
                    LINE  /PPP,ATANGL,75,LENGTH,2+7/32
  E        =        POINT /PPP
                    LINE  /PPP,ATANGL,150,LENGTH,3+7/16
  F        =        POINT /PPP
                    LINE  /PPP,ATANGL,225,LENGTH,2+25/64
  G        =        POINT /PPP
                    LINE  /PPP,ATANGL,255,LENGTH,1+29/32
  H        =        POINT /PPP
                    LINE  /PPP,ATANGL,165,LENGTH,3+3/8
  J        =        POINT /PPP
  P1       =        LINE  /PPP,ATANGL,285,LENGTH,2+3/32
                    LINE  /PPP,A
  P2       =        PT    /A,DY,15/16
                    CR    /P2,5/16
  P3       =        PT    /P2,DX,2+7/8
                    CR    /P3,11/32
                    PT    /DX,.125
               CTRLN,LN   /DX,-3.75
  P4       =        PT    /P3,ATANGL,225,LENGTH,15/32
  LCL      =CTRLN ,LN     /P4,ATANGL,45,LENGTH,3+20/32
            CTRLN ,LN     /(PT/LCL),ATANGL,45,LENGTH,1/2
  P5       =        PT    /(PT/LCL),ATANGL,75,LENGTH,1/2
  P6       =        PT    /(PT/LCL),ATANGL,255,LENGTH,15/16
  P7       =        PT    /P6,ATANGL,255,LENGTH,1/2
  P8       =        PT    /(PT/LCL),ATANGL,165,LENGTH,1/2
  LXL      =CTRLN ,LN     /P5,P7
  L12      =CTRLN ,LN     /P8,PERPTO,LXL
            CTRLN ,LN     /PPP,ATANGL,345,LENGTH,1/2
  P9       =        PT    /(PT/LCL),ATANGL,165,LENGTH,3/8
  P10      =        PT    /P6,ATANGL,165,LENGTH,3/8
                    LN    /P10,P9
                    ARC   /(PT/LCL),3/8,165,180,CLW
                    LN    /PPP,ATANGL,255,LENGTH,15/16
                    ARC   /P6,3/8,345,180 ,CLW
            CTRLN ,LN     /P6,ATANGL,165,LENGTH,1/2
            CTRLN ,LN     /P6,ATANGL,345,LENGTH,1/2
                    END   /PLATE
                    DRAW  /PLATE
```

```
DIMP  /.5,.1,1,1
DIM   /J,.5,285,60
DIM   /M,.5,165,-90
DIM   /G,.5,255,150
DIM   /F,.5,225,105
FINI/
```

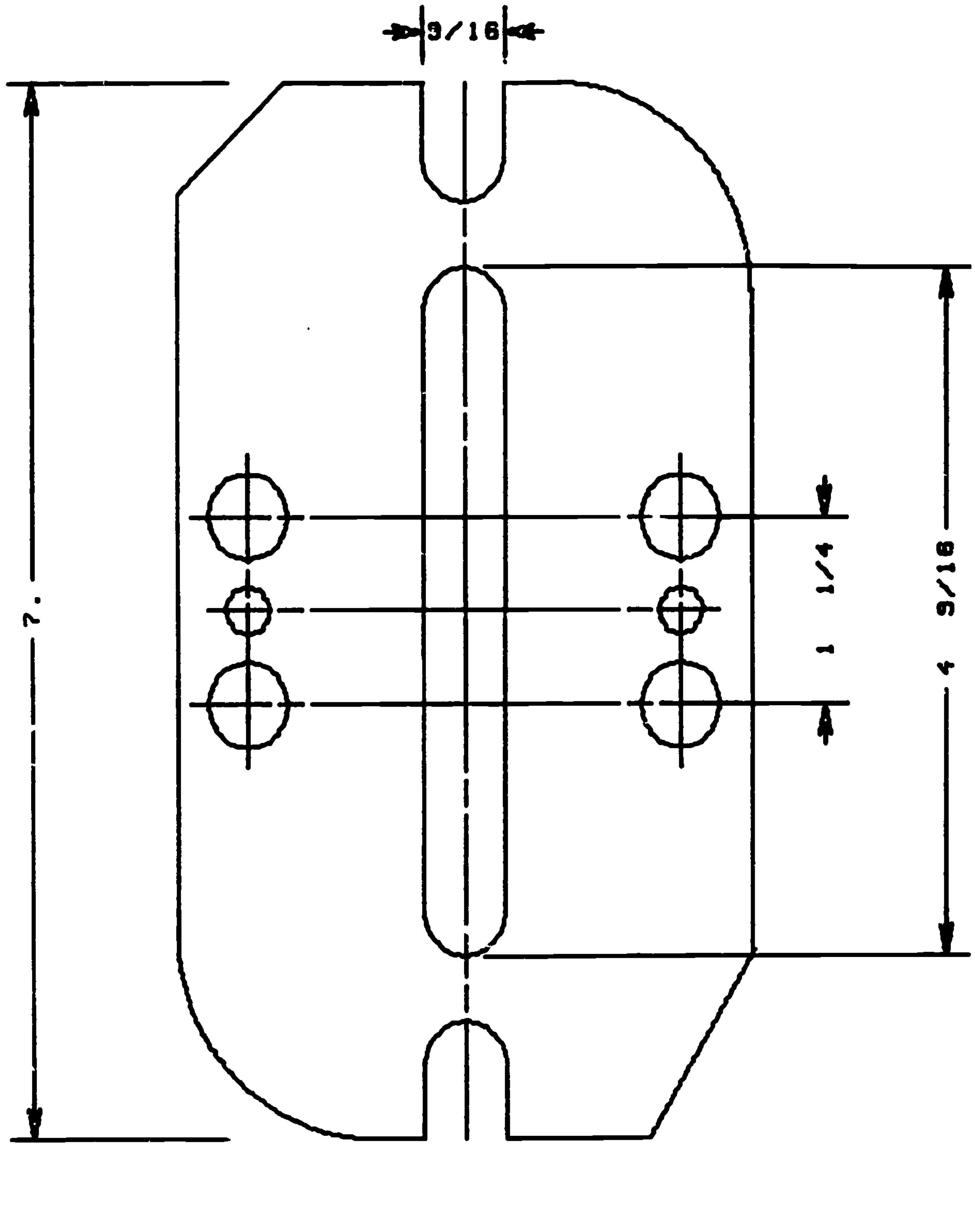

PLATE 10

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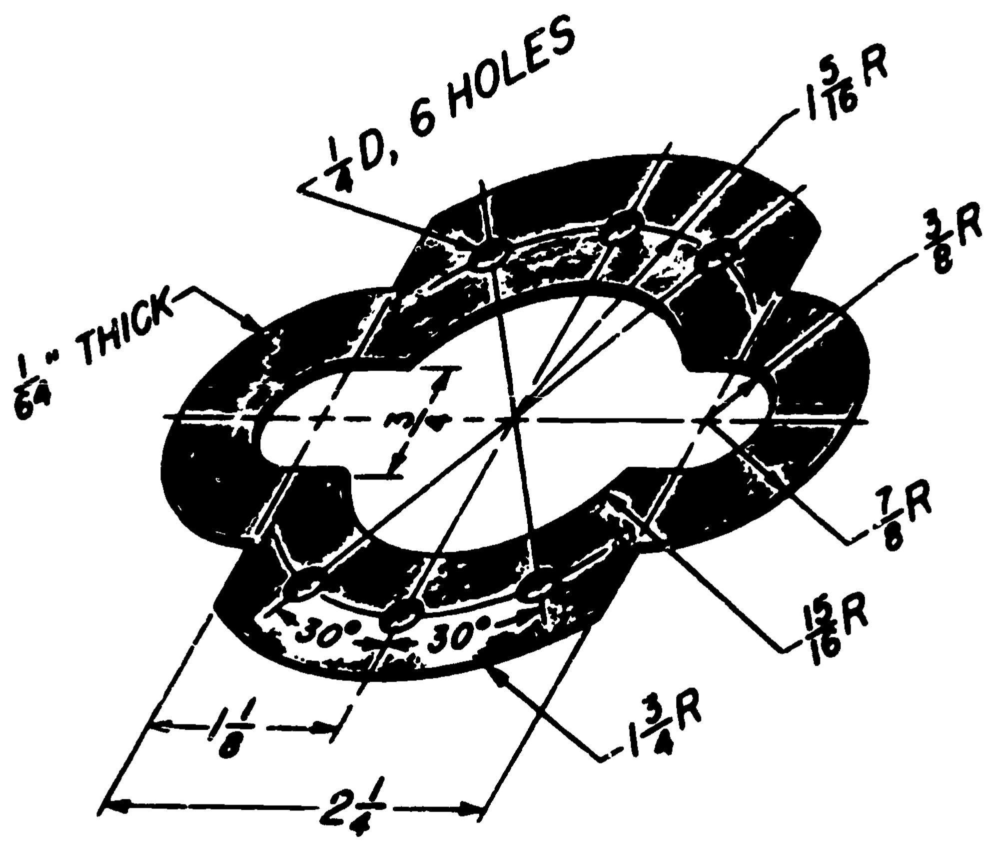
```
$$  PLATE 10        FIXTURE BASE WITH DIMENSIONS
  BOX      =        VIEW/
                    CALL   /FRAME1,,X=6.5,,Y=10,,ORX=1.5,,ORY=.5
                    END    /BOX
                    DRAW   /BOX
                    ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                    TITLE/5.5,1.5,@PLATE 10@
  BASE     =        VIEW  /
                    SCALE /3/4
                    ORIGIN/4.75,6
                    LINE   /2,-2.25,ATANGL,240,TILLY,-3.5
                    LINE   /PPP,ATANGL,180,TILLX,9/32
                    LINE   /DY,.5
                    ARC    /0,-3,9/32,0,180
                    LINE   /PPP,DY,-.5
                    LINE   /DX,-(2-9/32)
                    ARC    /1.375
                    LINE   /DY,6.25
                    LINE   /DX,3/4,DY,3/4
                    LINE   /DX,2-(3/4+9/32)
  P1       =        PT     /PPP
                    LINE   /DY,-.5
                    ARC    /0,3,9/32,180,180
                    LINE   /DY,.5
  P2       =        PT     /PPP
                    LINE   /DX,2-9/32
                    ARC    /1.375
                    LINE   /DY,-5.75
  P3       =        PT     /-1.5,-3.5
  P4       =        PT     /-1.5,3.5
                    END    /BASE
                    DRAW   /BASE
                    MASK   /@P,F16@
                    DIMP   /.25,.1,2,2
                    DIMST  /YLARGE,XCOMP,P1,P2,.25
                    DIM    /P1,P2
                    DIMP   /.5,.1,1,1
                    DIMST  /XSMALL,YCOMP,-2,-1,-2,1,.75
                    DIM    /P3,P4
  SLOT     =        VIEW   /
  P5       =        PT     /0,-(2+9/32)
  P6       =        PT     /0,2+9/32
                    LN     /9/32,0,DY,2
                    ARC    /0,2,9/32,0,180
                    LN     /DY,-2
            CTRLN,LN       /0,0,DY,3.5
                    END    /SLOT
                    DRAW   /SLOT
                    DRAW   /MIRY(SLOT)
                    DIMST  /XLARGE,YCOMP,P5,P6,2.5
                    DIM    /P5,P6
  CIR      =        VIEW   /
```

```
P7      =      PT      /1.5,-5/8
P8      =      PT      /1.5,5/8
         CTRLN,LN      /0,-5/8,DX,1+29/32
         CTRLN,LN      /0,0,DX,1+25/32
         CTRLN,LN      /0,5/8,DX,1+29/32
         CTRLN,LN      /1.5,-(1+1/32),DY,2+1/16
               CR      /1.5,-5/8,9/32
               CR      /1.5,0,5/32
               CR      /1.5,5/8,9/32
               END     /CIR
               DRAW    /CIR
               DRAW    /MIRX(CIR)
               DIMST   /XLARGE,YCOMP,P7,P8,.75
               DIMP    /.6,.1,2,2
               DIM     /P7,P8
 FINI /
```



SKETCH II

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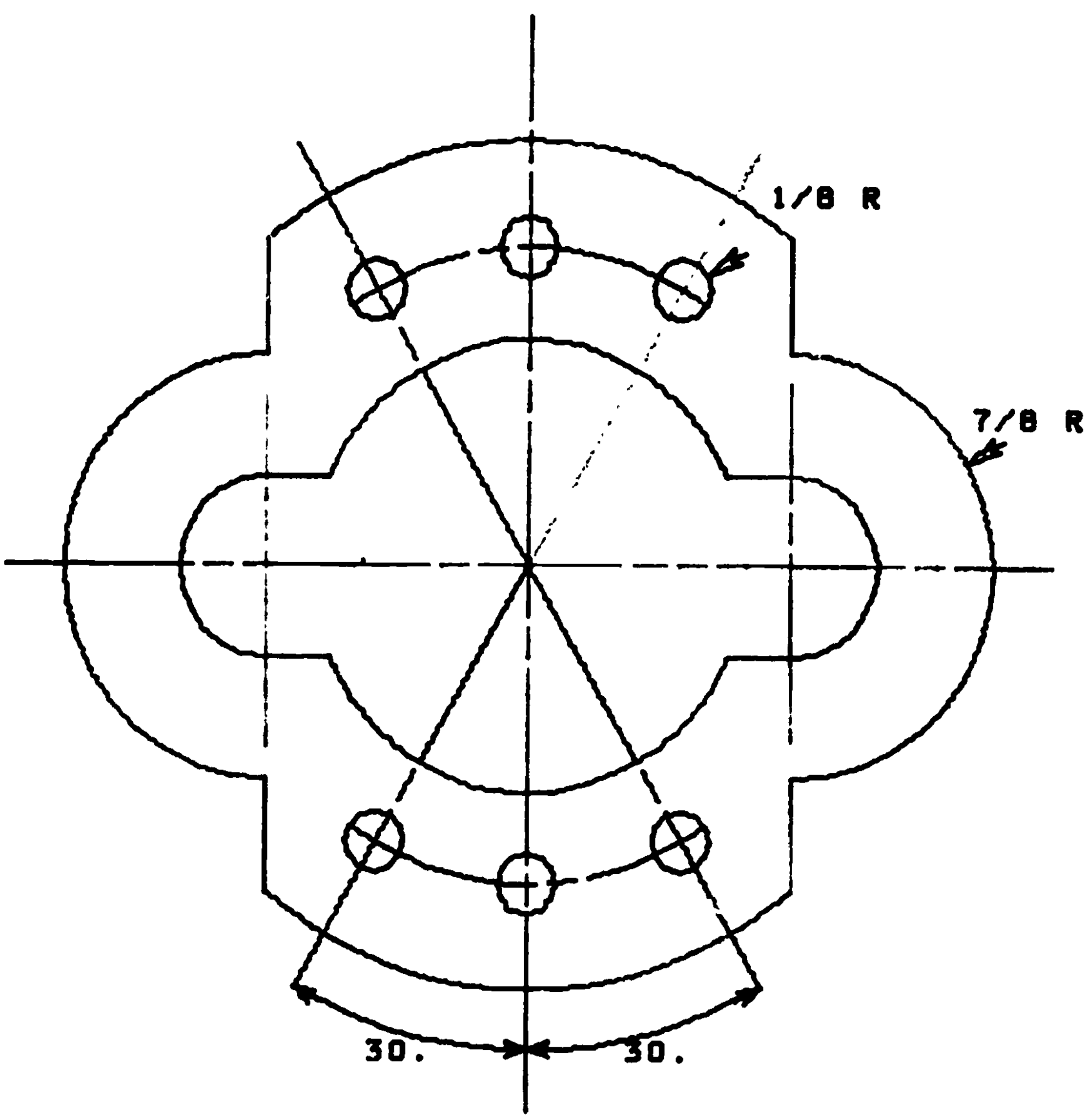

PLATE 11

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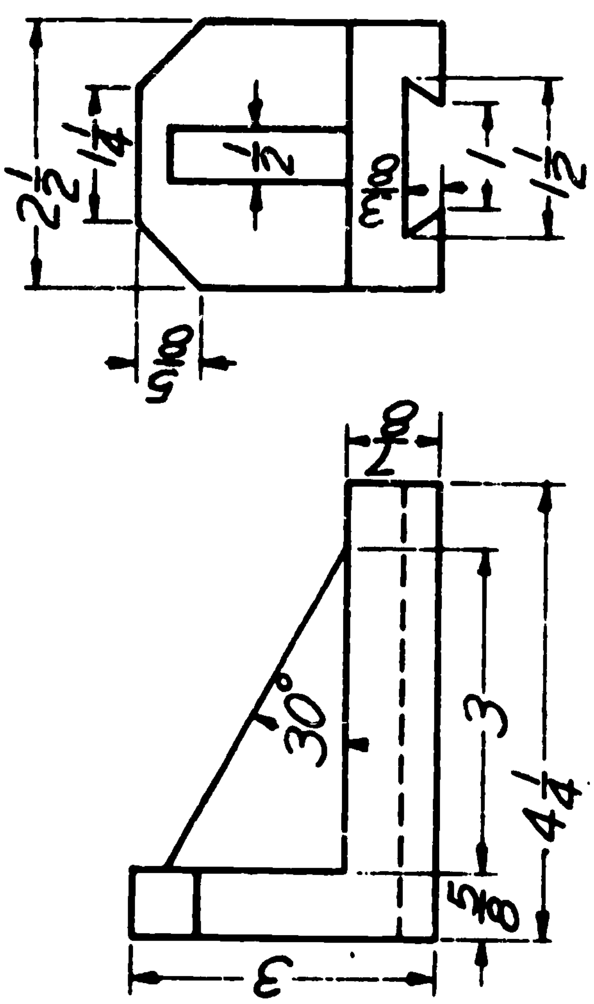
```
$$  PLATE 11          INTERSECTION OF ARCS-GASKET
                     ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                     TITLE /6,1.5,@PLATE 11@
    GASKET=          VIEW/
    L1     =CONSTR,LINE   /1.125,-3,DY,.01
    L2     =CONSTR,LINE   /-1.125,-3,DY,.01
    L3     =CONSTR,LINE   /-2,-3/8,DX,.01
    L4     =CONSTR,LINE   /-2,3/8,DX,.01
    C1     =CONSTR,CIRCLE/0,0,1.75
    P1     =         POINT /YLARGE,INTOF,L2,C1
    P2     =         POINT /YLARGE,INTOF,L1,C1
    P3     =         POINT /YSMALL,INTOF,L1,C1
    P4     =         POINT /YSMALL,INTOF,L2,C1
    C2     =CONSTR,CIRCLE/1.125,0,7/8
    C3     =CONSTR,CIRCLE/-1.125,0,7/8
    P5     =         POINT /YLARGE,INTOF,L1,C2
    P6     =         POINT /YSMALL,INTOF,L1,C2
    P8     =         POINT /YLARGE,INTOF,L2,C3
    P7     =         POINT /YSMALL,INTOF,L2,C3
                     ARC    /P1,P2,YSMALL,RADIUS,1.75,CLW
                     LINE   /PPP,P5
                     ARC    /P5,P6,XSMALL,RADIUS,7/8,CLW
                     LINE   /PPP,P3
                     ARC    /P3,P4,YLARGE,RADIUS,1.75,CLW
                     LINE   /PPP,P7
                     ARC    /P7,P8,XLARGE,RADIUS,7/8,CLW
                     LINE   /PPP,P1
    C4     =CONSTR,CIRCLE/0,0,15/16
    C5     =CONSTR,CIRCLE/-1.125,0,3/8
    C6     =CONSTR,CIRCLE/1.125,0,3/8
    P20    =         POINT /YLARGE,INTOF,L1,C6
    P21    =         POINT /YSMALL,INTOF,L1,C6
    P22    =         POINT /YSMALL,INTOF,L2,C5
    P23    =         POINT /YLARGE,INTOF,L2,C5
    P24    =         POINT /XSMALL,INTOF,L4,C4
    P25    =         POINT /XLARGE,INTOF,L4,C4
    P26    =         POINT /XLARGE,INTOF,L3,C4
    P27    =         POINT /XSMALL,INTOF,L3,C4
                     ARC    /P24,P25,YSMALL,RADIUS,15/16,CLW
                     LINE   /PPP,P20
                     ARC    /P20,P21,XSMALL,RADIUS,3/8,CLW
                     LINE   /PPP,P26
                     ARC    /P26,P27,YLARGE,RADIUS,15/16,CLW
                     LINE   /P27,P22
                     ARC    /P22,P23,XLARGE,RADIUS,3/8,CLW
                     LINE   /P23,P24
    CLACIR=CTRLN ,SHAPE /
                     LN     /-2.25,0,2.25,0
                     LN     /0,-2.25,0,2.25
                     LN     /-1.125,-.75,-1.125,.75
                     LN     /1.125,-.75,1.125,.75
                     LN     /0,0,ATANGL,60,LENGTH,2
```

```
                 LN     /0,0,ATANGL,120,LENGTH,2
                 LN     /0,0,ATANGL,240,LENGTH,2
                 LN     /0,0,ATANGL,300,LENGTH,2
                 ARC    /0,0,1+5/16,55,70
                 ARC    /0,0,1+5/16,235,70
                 END    /CLACIR
    L101 =CONSTR,LN     /0,0,ATANGL,60,LENGTH,1+5/16
C7        =     CIRCLE/(PT/L101),1/8
    L111 =CONSTR,LN     /0,0,ATANGL,120,LENGTH,1+5/16
                CIRCLE/(PT/L111),1/8
    L112 =CONSTR,LN     /0,0,ATANGL,240,LENGTH,1+5/16
                CIRCLE/(PT/L112),1/8
                CIRCLE/0,1+5/16,1/8
    L113 =CONSTR,LN     /0,0,ATANGL,300,LENGTH,1+5/16
                CIRCLE/(PT/L113),1/8
                CIRCLE/0,-1-5/16,1/8
                END    /GASKET
                ORIGIN/4.75,6
                DRAW   /GASKET
                MASK   /@H,F8@
                DIMP   /.5,.2,1,1
                DIM    /0,0,2,240,30
                DIM    /0,0,2,270,30
                DIMP   /1.2,.2,0,2
                DIMCR  /C7,30,@1/8 R@
                DIMP   /3.5,.2,0,2
                DIMCR  /C2,30,@7/8 R@
                FINI   /
```



SKETCH 12

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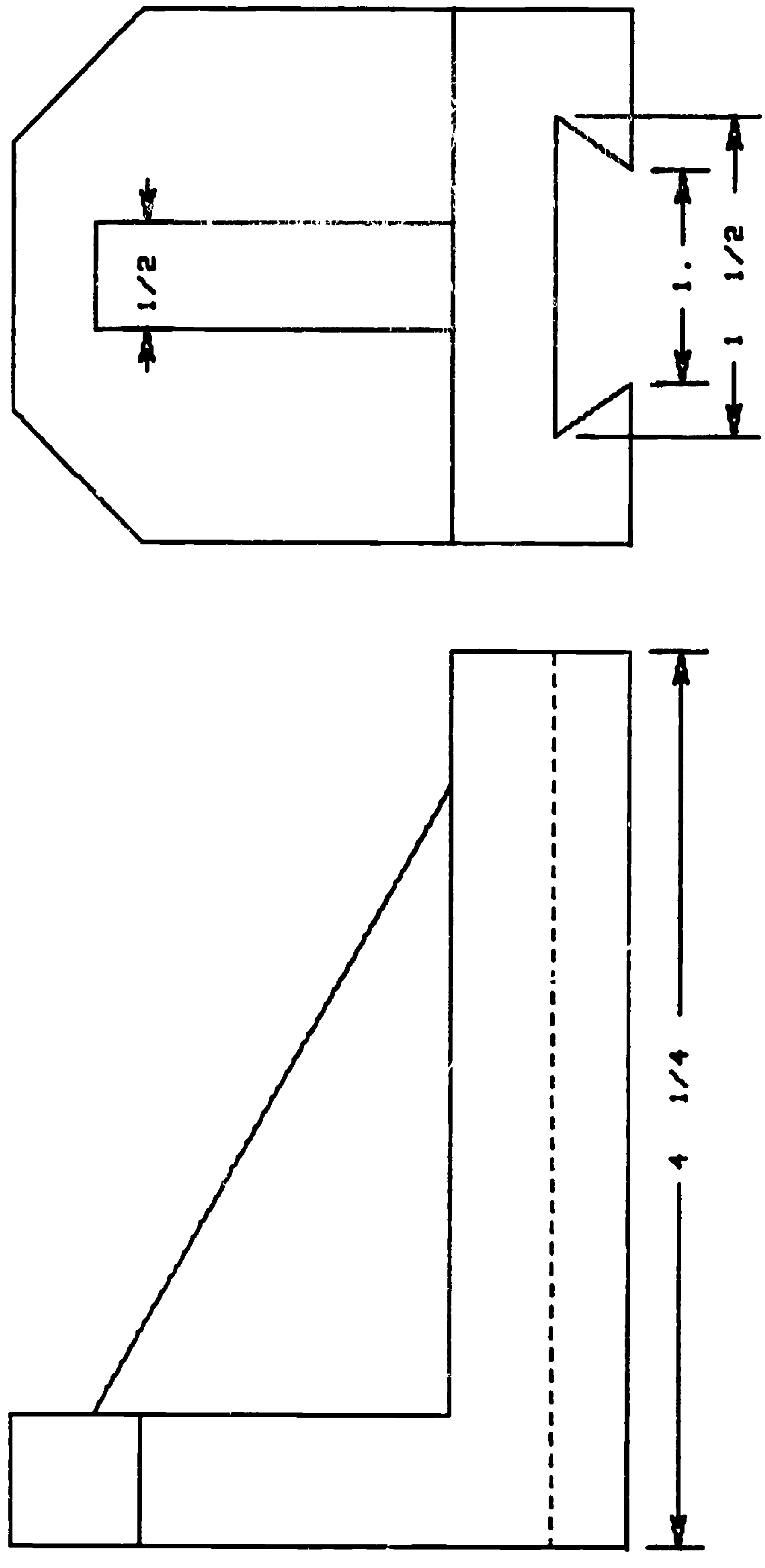

PLATE 12

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```
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$$  PLATE 12        TWO VIEW DRAWING WITH UNKNOWN DISTANCE-DOVETAIL STOP
                    (LONG -X-)
                    ALPHAP/(.2,.2,0,-.2),(0,0,0,270)
                    TITLE /1.5,2.5,@PLATE 12@
 SIDE    =          VIEW  /
                    LN     /DX,4.25
 P2      =          PT     /PPP
                    LN     /DY,7/8
                    LN     /DX,-(4.25-5/8)
                    LN     /DY,2.125
                    LN     /DX,-5/8
                    LN     /DY,-3
 P1      =          PT     /PPP
                    LN     /0,2.375,DX,5/8
                    LN     /3.625,7/8,ATANGL,150,TILLX,5/8
         DOTTED,LN         /0,3/8,DX,4.25
                    END    /SIDE
                    ORIGIN/2.25,2.25
                    DRAW   /SIDE
                    MASK   /@P,F16@
                    DIMP   /.5,.1,1,1
                    DIMST /YSMALL,XCOMP,P1,P2,.25
                    DIM    /P1,P2
 FRONT   =          VIEW  /
                    LN     /DX,3/4
 P3      =          PT     /PPP
                    LN     /DX,-.25,DY,3/8
 P4      =          PT     /PPP
                    LN     /DX,1.5
 P5      =          PT     /PPP
                    LN     /DX,-.25,DY,-3/8
 P6      =          PT     /PPP
                    LN     /DX,3/4
                    LN     /DY,2.375
                    LN     /DX,-5/8,DY,5/8
                    LN     /DX,-1.25
                    LN     /DX,-5/8,DY,-5/8
                    LN     /DY,-2.375
                    LN     /1,.875,DY,3/COSD(30)*SIND(30)
 P7      =          PT     /PPP
                    LN     /DX,.5
 P8      =          PT     /PPP
                    LN     /PPP,ATANGL,270,TILLY,7/8
         CONSTR,LN          /DX,1
                    LN     /DX,-2.5
                    END    /FRONT
                    ORIGIN/7,2.25
                    DRAW   /FRONT
                    DIMST /YSMALL,XCOMP,P3,P6,.25
                    DIM    /P3,P6
                    DIM    /P4,P5
                    DIMP   /.3,.1,2,2
```
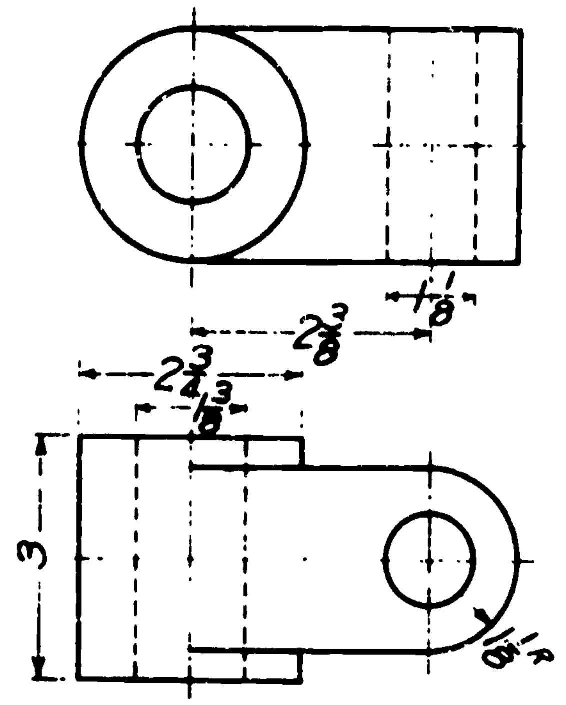

```
DIMST /YSMALL,XCOMP,P7,P8,.25
DIMNN /P7,P8
FINI  /
```



SKETCH 13

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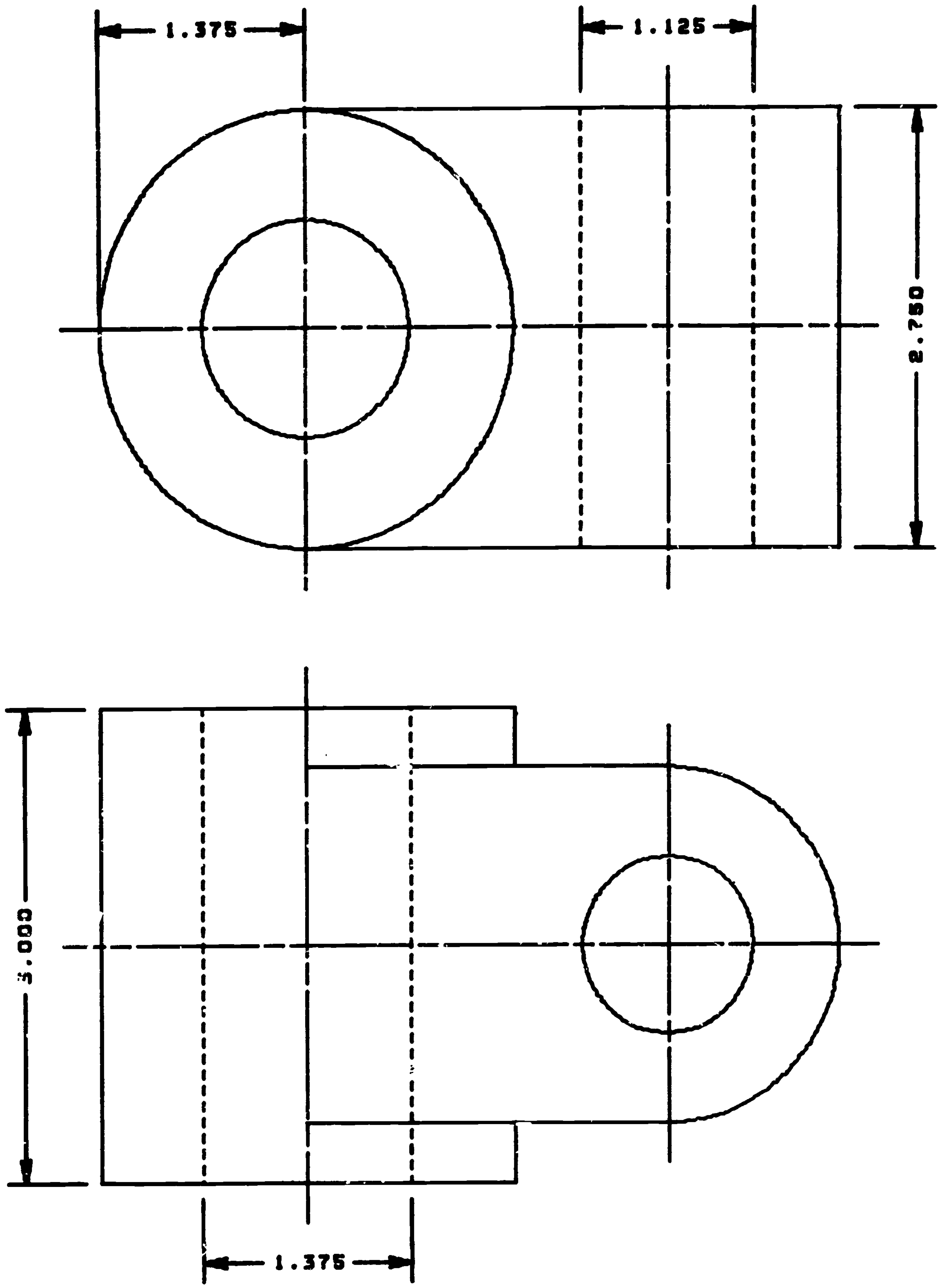

PLATE 13

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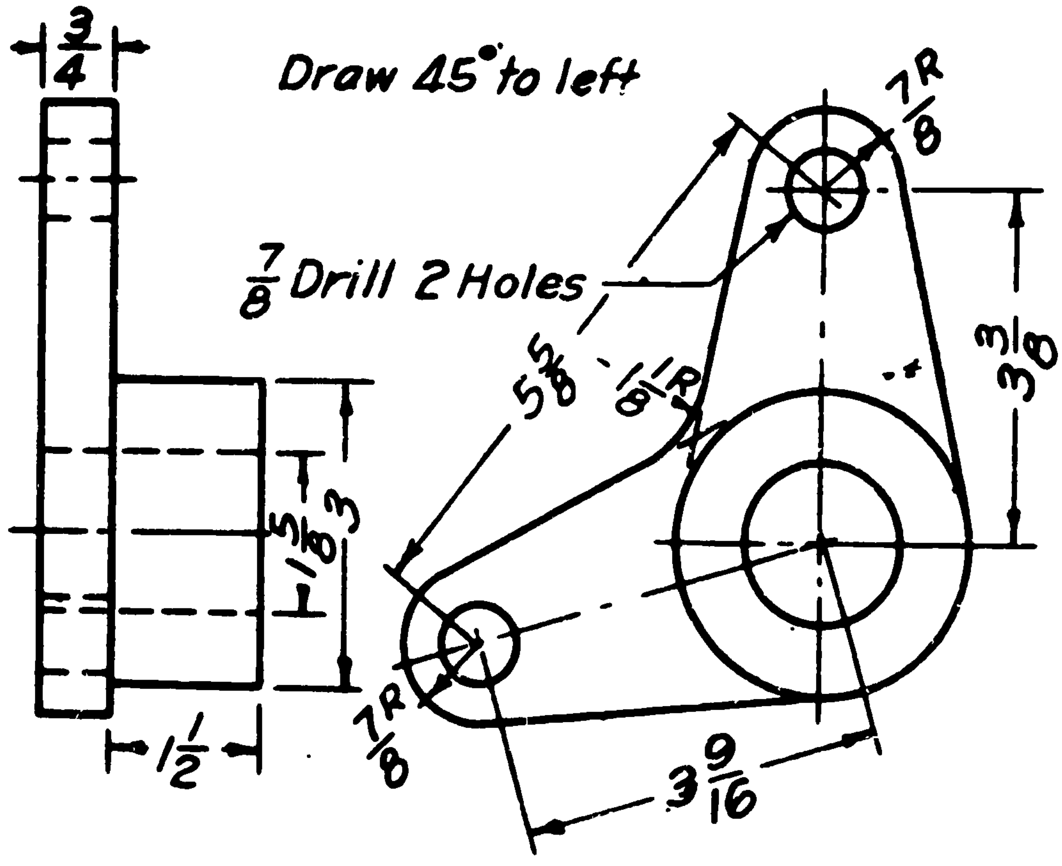
```
$$  PLATE 13        TWO VIEW DRAWING-CROSS LINK
                    ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                    TITLE /6,1.5,@PLATE 13@
 TOP       =        VIEW  /
 L1        =CTRLN ,LN     /-1.625,0,DX,1.625+2.375+1.125+.25
            CTRLN ,LN     /2.375,1.625,DY,-1.625*2
            CTRLN ,LN     /0,-1.625,DY,1.625*2
                    CR    /0,0,1.375/2
 C1        =        CR    /0,0,2.75/2
                    LN    /0,1.375,DX,3.5
 P1        =        PT    /PPP
                    LN    /DY,-2.75
 P2        =        PT    /PPP
                    LN    /PPP,LEFT,TANTO,C1
           DOTTED,LN      /2.375-1.125/2,1.375,DY,-2.75
           CONSTR,LN      /DX,1.125
           DOTTED,LN      /DY,2.75
 P4        =        PT    /PPP
 P3        =        PT    /2.375-1.125/2,1.375
 P5        =        PT    /0,1.375
 P6        =        PT    /XSMALL,INTOF,L1,C1
                    END   /TOP
                    ORIGIN/2.312+11/8,8.0
                    DRAW  /TOP
                    MASK  /@P,D3@
                    DIMP  /.5,.1,1,1
                    DIMST /YLARGE,XCOMP,P3,P4
                    DIM   /P3,P4
                    INDEX /-1
                    DIM   /P6,P5
                    DIMP  /.5,.1,1,1
                    DIMST /XLARGE,YCOMP,P1,P2
                    DIM   /P1,P2
 BOTTOM    =        VIEW  /
           CTRLN ,LN      /0,1.375,DY,-(1.125*2+.5)
           CTRLN ,LN      /1.375,0,DX,-(1.125+2.375+2.75/2+.5)
           CTRLN ,LN      /-2.375,1.75,DY,-3.5
                    LN    /-(2.375-2.75/2),1.125,DY,1.5-1.125
                    LN    /DX,-2.75
 P7        =        PT    /PPP
                    LN    /DY,-3
 P8        =        PT    /PPP
                    LN    /DX,2.75
                    LN    /DY,1.5-1.125
           CONSTR,LN      /DX,-(2.75/2)
                    LN    /DX,2.375
                    ARC   /0,0,1.125,270,180
                    LN    /DX,-2.375
                    CR    /0,0,1.125/2
           DOTTED,LN      /-(2.375+1.375/2),1.5,DY,-3
 P9        =        PT    /PPP
           CONSTR,LN      /DX,1.375
```

```
P10      =       PT     /PPP
          DOTTED,LN     /DY,3
                 END    /BOTTOM
                 ORIGIN/4.687+11/8,4.125
                 DRAW   /BOTTOM
                 MASK   /@P,D3@
                 DIMP   /.5,.1,1,1
                 DIMST  /XSMALL,YCOMP,P8,P7
                 DIM    /P8,P7
                 DIMST  /YSMALL,XCOMP,P9,P10
                 DIM    /P9,P10
                 FINI   /
```



SKETCH 14

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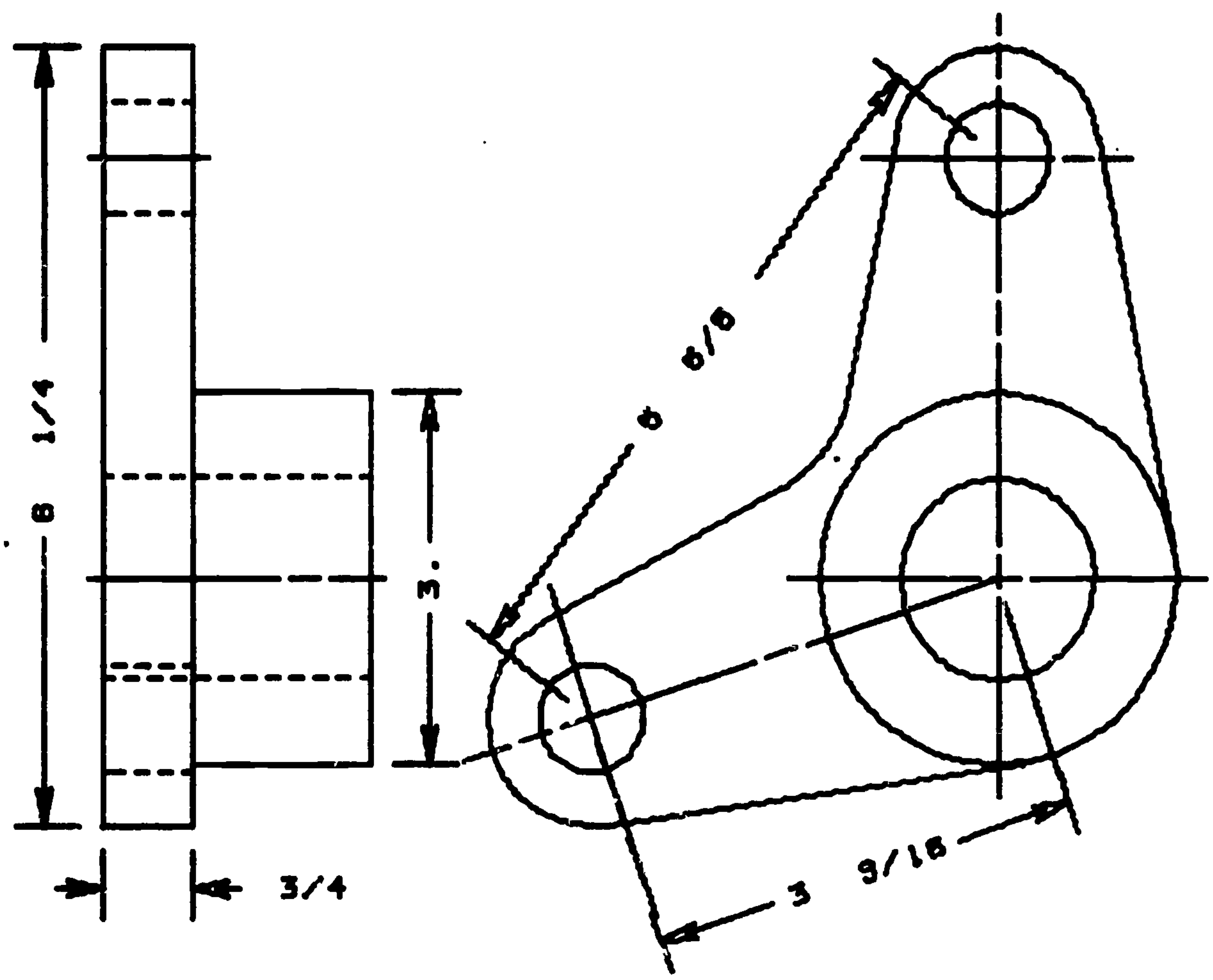

PLATE 14

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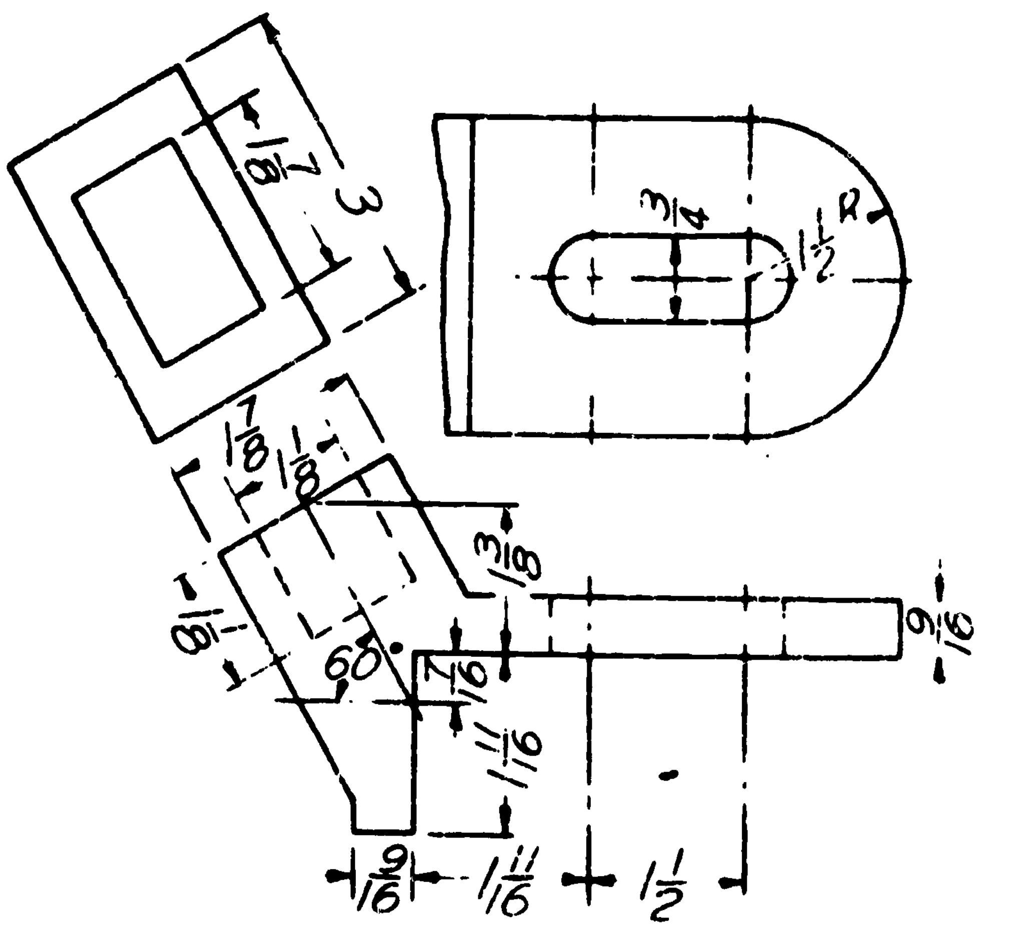
```
$$  PLATE 14        TWO VIEW DRAWING-BELL CRANK
                   ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                   TITLE /6,1.5,@PLATE 14@
                   SCALE /.5
 CRANK    =        VIEW  /
                   CIRCLE/0,0,1.625/2
 C1       =        CIRCLE/0,0,1.5
 C2       =CONSTR,CR      /0,0,3.562
 C3       =CONSTR,CR      /0,3.375,5.625
           CONSTR,LN      /0,0,DY,4.25
 L7       =CONSTR,LN      /PPP,DX,-.1
           CONSTR,LN      /PPP,DY,-(.875-.875/2)
 L6       =CONSTR,LN      /PPP,DX,-.1
 P1       =        PT     /XSMALL,INTOF,C2,C3
 C4       =CONSTR,CR      /P1,.875
 C5       =CONSTR,CR      /0,3.375,.875
 L1       =CONSTR,LN      /LEFT,TANTO,C1,LEFT,TANTO,C5
 L2       =CONSTR,LN      /RIGHT,TANTO,C1,RIGHT,TANTO,C4
 P2       =        PT     /INTOF,L1,L2
 P3       =        LN     /RIGHT,TANTO,C1,RIGHT,TANTO,C5
 P4       =CONSTR,LN      /P2,LEFT,TANTO,C5
                   ARC    /(PT/P3),(PT/P4),YSMALL,RADIUS,.875
                   LN     /PPP,P2
                   ARC    /1.125
 P5       =        LN     /P2,RIGHT,TANTO,C4
 P6       =CONSTR,LN      /LEFT,TANTO,C1,LEFT,TANTO,C4
                   ARC    /(PT/P5),(PT/P6),XLARGE,RADIUS,.875
                   LN     /(PT/P6),RIGHT,TANTO,C1
 L3       =CONSTR,LN      /0,0,P1
           CTRLN ,LN      /ANGOF(L3),LENGTH,4.687
           CTRLN ,LN      /-1.75,0,DX,3.5
           CTRLN ,LN      /0,-1.75,DY,6.25
           CTRLN ,LN      /-1.125,3.375,DX,2.25
                   CR     /0,3.375,.875/2
 P7       =CONSTR,LN      /ANGOF(L3),LENGTH,3.562
 A1       =                ATAND(L3)
           CONSTR,LN      /PPP,ATANGL,A1-90,LENGTH,1.125
           CTRLN ,LN      /PPP,ATANGL,A1+90,LENGTH,2.25
                   CR     /(PT/P7),.875/2
 L4       =CONSTR,LN      /0,0,0,3.375
 L5       =CONSTR,LN      /P1,(PT/L4)
 P8       =        PT     /INTOF,P6,C4
 L8       =CONSTR,LN      /P8,DX,-4.25
                   LN     /PPP,DX,.75
 P99      =        PT     /PPP
 L10      =CONSTR,LN      /PPP,DY,.1
 P9       =        PT     /INTOF,L7,L10
 L9       =        LN     /P99,P9
                   LN     /PPP,DX,-.75
 P1212    =        PT     /PPP
 L12      =CONSTR,LN      /PPP,DY,-.1
 P12      =        PT     /INTOF,L12,L8
```

```
                 LN     /P1212,P12
P10     =        PT     /INTOF,P6,C1
L11     =CONSTR,LN      /PPP,DX,-.1
P11     =        PT     /INTOF,L9,L11
                 LN     /P11,DX,1.5
P15     =        PT     /PPP
                 LN     /PPP,DY,3
P16     =        PT     /PPP
                 LN     /PPP,DX,-1.5
         CONSTR,LN      /PPP,DX,-.75
         CONSTR,LN      /PPP,DY,-.6875
         DOTTED,LN      /PPP,DX,2.25
         CONSTR,LN      /PPP,DY,-1.625
         DOTTED,LN      /PPP,DX,-2.25
         CONSTR,LN      /PPP,DY,1.625/2
         CONSTR,LN      /PPP,DX,-.125
         CTRLN ,LN      /PPP,DX,2.5
         CONSTR,LN      /P1,DY,.875/2
L13     =CONSTR,LN      /PPP,DX,-.1
P13     =        PT     /INTOF,L13,L10
         DOTTED,LN      /P13,DX,-.75
         CONSTR,LN      /PPP,DY,-.875
         DOTTED,LN      /PPP,DX,.75
P14     =        PT     /INTOF,L6,L10
         DOTTED,LN      /P14,DX,-.75
         CONSTR,LN      /PPP,DY,-.875
         DOTTED,LN      /PPP,DX,.75
         CONSTR,LN      /PPP,DY,.875/2
         CONSTR,LN      /PPP,DX,.125
         CTRLN ,LN      /PPP,DX,-1
                 END    /CRANK
                 ORIGIN/6.25,5.5
                 DRAW   /CRANK
                 MASK   /@P F32 TN@
                 DIMP   /.5,.1,1,1
                 DIMST  /XSMALL,YCOMP,P12,P1212,.25
                 DIM    /P12,P1212
                 DIMST  /XLARGE,YCOMP,P15,P16,.25
                 DIM    /P15,P16
                 DIMST  /YLARGE,TRUE,L5,.75/2
                 DIM    /L5
                 DIMST  /YSMALL,TRUE,L3,.75
                 DIM    /L3
                 DIMP   /2.2,.1,2,2
                 DIMST  /YSMALL,XCOMP,P12,P99,.25
                 DIM    /P12,P99
                 FINI   /
```



SKETCH 15

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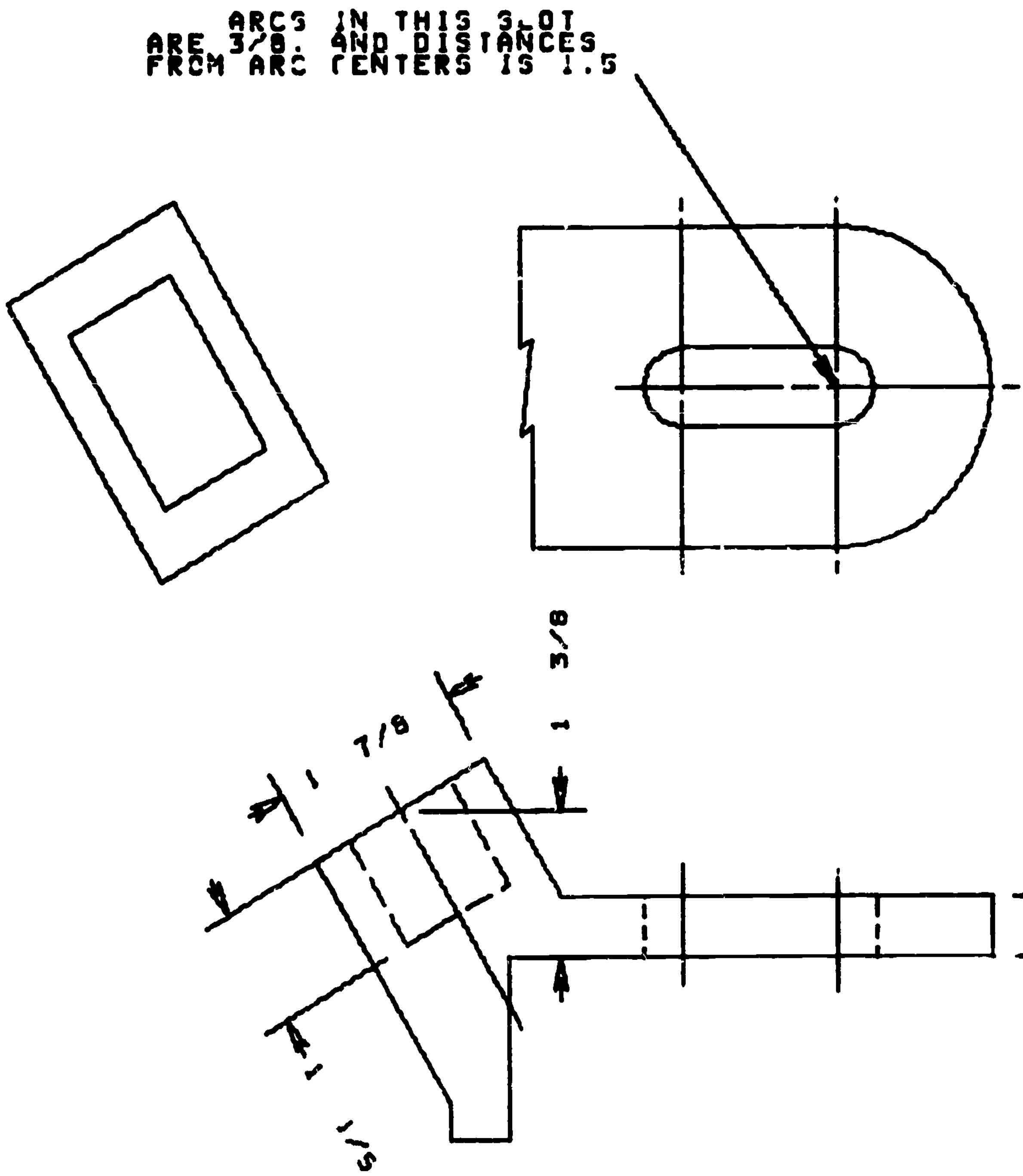

PLATE 15

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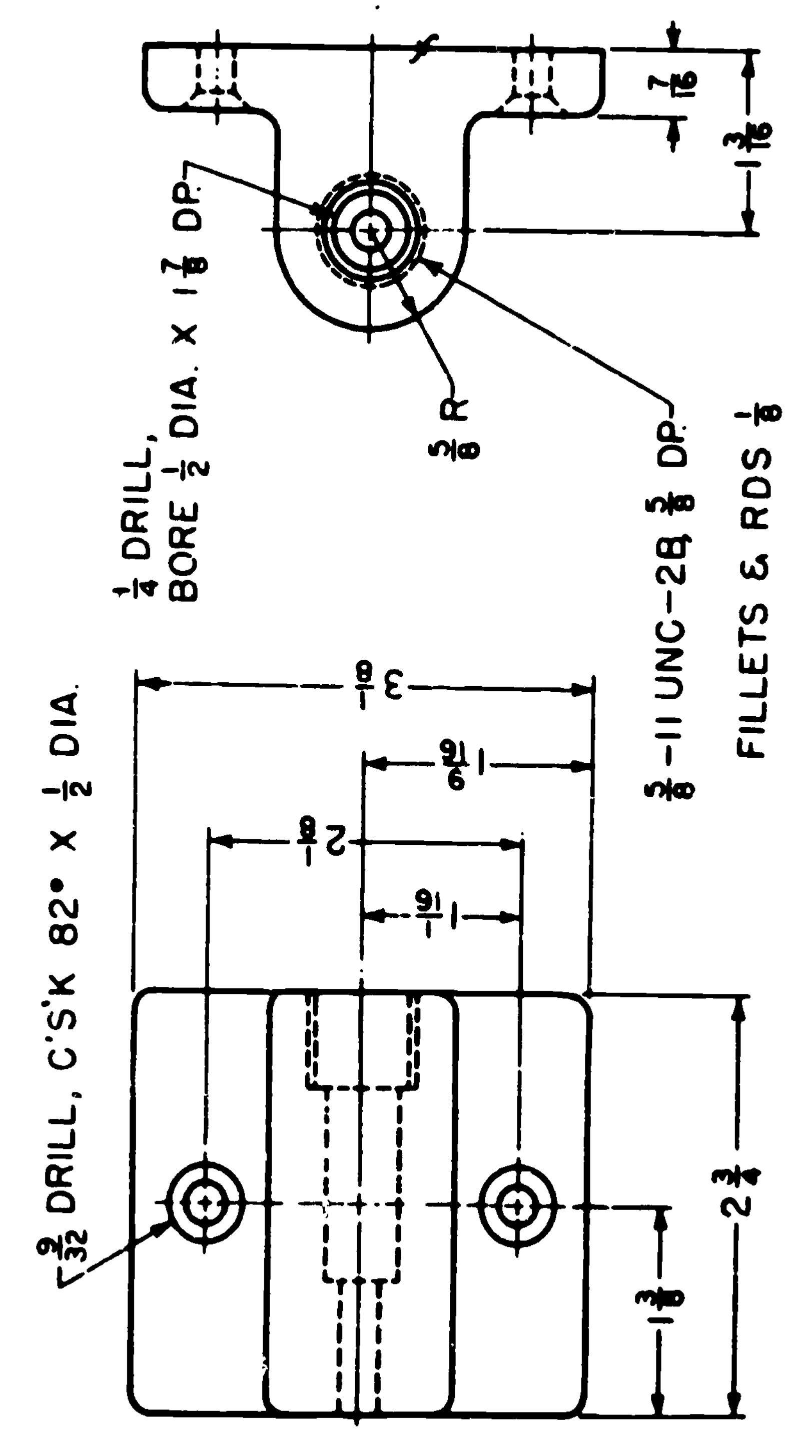
```
$$  PLATE 15          DRAWING AN AUXILIARY VIEW-STRUT ANCHOR
                     ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                     TITLE /6,1.5,@PLATE 15@
                     SCALE /1/2
  FRONT    =         VIEW  /
                     ORIGIN/4.5,2+1+11/16
                     LN     /DX,9/16
  LXX      =         LN     /DY,1+11/16
  PX5      =         PT     /PPP
  P1       =         POINT  /9/16,1+11/16-7/16
           CONSTR,LN        /P1,ATANGL,120,TILLY,1+11/16+1+3/8
  P2       =         PT     /PPP
           CONSTR,LN        /(POINT/P2),ATANGL,30,LENGTH,1.875/2
  P3       =         PT     /PPP
                     LN     /.562,1.687,DX,1.687+1.5+1.5
  PX1      =         PT     /PPP
  P4       =         LN     /DY,.562
  P5       =CONSTR,LN       /(POINT/P3),ATANGL,300,TILLY,2.25
                     LN     /(POINT/P4),(POINT/P5)
                     LN     /(POINT/P5),(POINT/P3)
                     LN     /(POINT/P3),ATANGL,210,LENGTH,1.875
  PX       =         PT     /PPP
           CONSTR,LN        /PX,ATANGL,120,LENGTH,3
  P11      =         PT     /PPP
           CONSTR,LN        /P11,ATANGL,300,LENGTH,3
                     LN     /PPP,ATANGL,300,TILLX,0
                     LN     /PPP,ATANGL,270,TILLY,0
           CONSTR,LN          /(PT/P2),ATANGL,210,LENGTH,.562
  PY       =         PT     /PPP
           DASHED,LN        /PPP,ATANGL,300,LENGTH,1.125
  PX2      =         PT     /PPP
           DASHED,LN        /PPP,ATANGL,30,LENGTH,1.125
           DASHED,LN        /PPP,ATANGL,120,LENGTH,1.125
  P6       =CONSTR,LN       /(PT/P2),ATANGL,120,LENGTH,.25
  P7       =CONSTR,LN       /(PT/P1),ATANGL,300,LENGTH,.25
           CTRLN ,LN        /(PT/P7),(PT/P6)
           CTRLN ,LN        /2.25,1.687-.25,DY,1.125
           CTRLN ,LN        /3.75,2.5,DY,-1.125
  PX3      =         PT     /1.875,1.687
           DOTTED,LN        /1.875,1.687,DY,.562
           CONSTR,LN        /DX,2.25
           DOTTED,LN        /DY,-.562
  PX4      =         PT     /PPP
                     END    /FRONT
                     DRAW   /FRONT
                     MASK   /@P,F16@
                     DIMP   /2,.1,2,2
                     DIMST /XLARGE,YCOMP,PX1,(PT/P4),.25
                     DIM    /PX1,(PT/P4)
                     DIMST /XLARGE,YCOMP,LXX
                     DIMNE ,PX5,P2
                     DIMP   /.5,.1,2,2
```

```
                    DIMST /YLARGE,TRUE,PX,P3,.25
                    DIM   /PX,P3
                    DIMP  /2,.1,2,2
                    DIMST /YSMALL,TRUE,PY,PX2,.50
                    DIM   /PY,PX2
TOP       =         VIEW  /
DIST1     =               DIST((PT/P4),(PT/P5))
P8        =         PT    /-(DIST1+.25),-1.5
                    LN    /P8,DX,DIST1+.25-1.5
                    ARC   /-1.5,0,1.5,270,180
P9        =         LN    /PPP,DX,-(DIST1+.375-1.5)
                    LN    /(PT/P9),DY,-1.125
P10       =         LN    /PPP,ATANGL,30,LENGTH,.125
                    LN    /P8,DY,1.125
                    LN    /PPP,ATANGL,210,LENGTH,.125
                    LN    /PPP,(PT/P10)
L1        =CTRLN ,LN    /-3.625,0,DX,3.875
           CTRLN ,LN    /-3,-1.75,DY,3.5
L2        =CTRLN ,LN    /-1.5,1.75,DY,-3.5
                    LN    /-1.5,-.375,DX,-1.5
                    ARC   /-3,0,.375,270,-180
                    LN    /DX,1.5
                    ARC   /-1.5,0,.375,90,-180
PX6       =         PT    /XLARGE,INTOF,L1,L2
                    END   /TOP
                    ORIGIN/7.125,5.5+1+11/16
                    DRAW  /TOP
                    ALPHAP/(.1,.1,.1,0),(0,.1,0,-5)
                    NOTER /PX6,-1,1.5,@FROM ARC CENTERS IS 1.5@,$
@ARE 3/8, AND DISTANCES@,@    ARCS IN THIS SLOT@
SIDE      =         VIEW  /
                    REFSYS/P11,ATANGL,30
                    LN    /0,0,DX,1+7/8
                    LN    /PPP,DY,3
                    LN    /PPP,DX,-1-7/8
                    LN    /PPP,DY,-3
                    LN    /6/16,9/16,DX,1+1/8
                    LN    /PPP,DY,1+7/8
                    LN    /PPP,DX,-1-1/8
                    LN    /PPP,DY,-1-7/8
                    END   /SIDE
                    ORIGIN/4.5,2+1+11/16
                    DRAW  /SIDE
```



SKETCH 16

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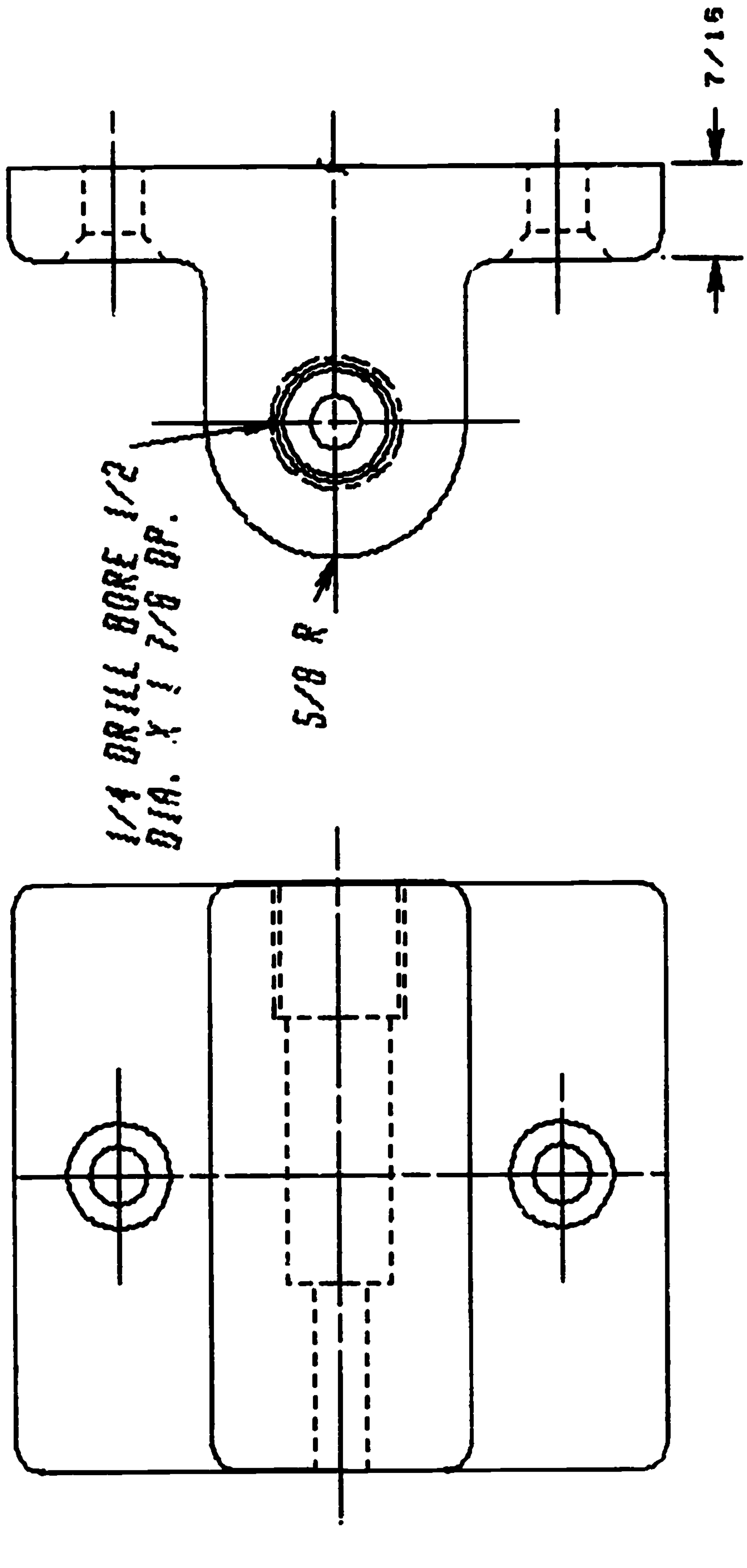

PLATE 16

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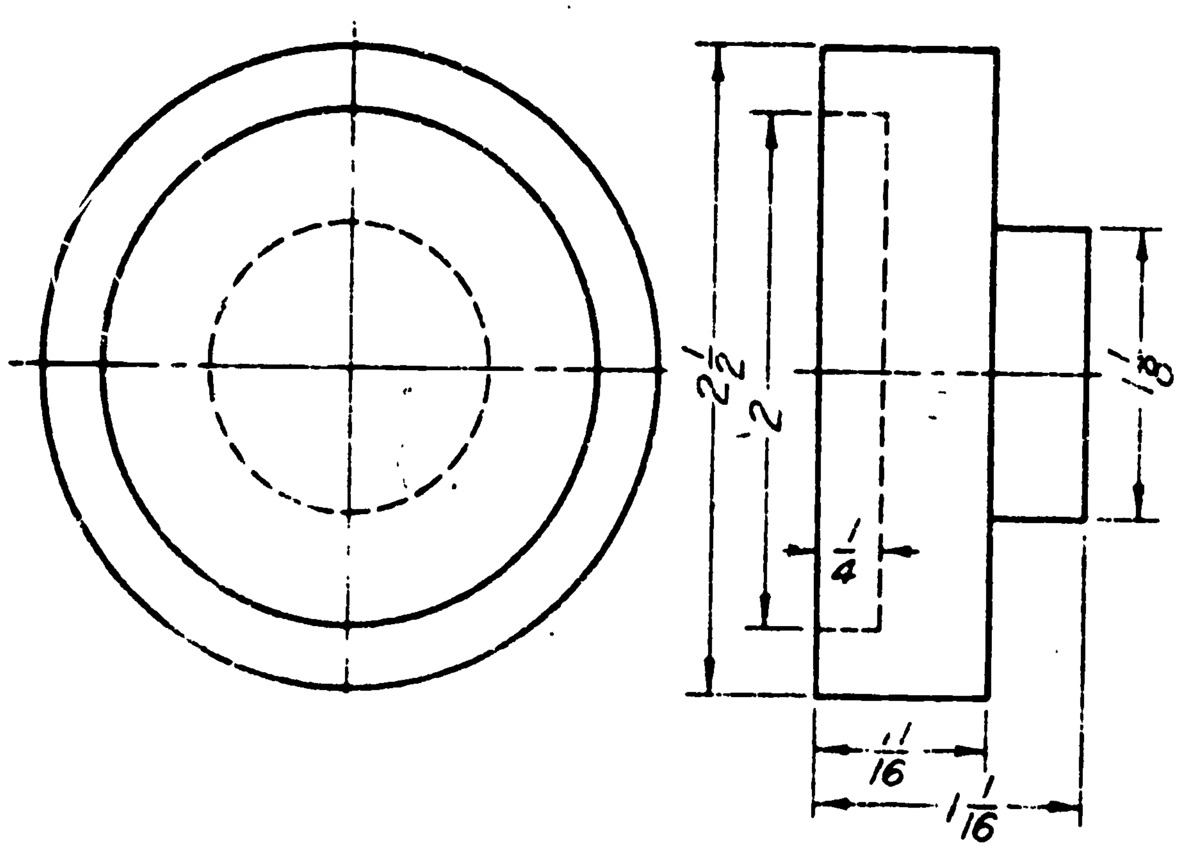
```
$$ PLATE 16        TWO VIEW DRAWING USING FILLETS  (LONG -X-)
 TOP      =        VIEW   /
                   LN     /0,3,DY,-3
                   ARC    /.125
                   LN     /DX,2.75
                   ARC    /.125
                   LN     /DY,3.125
                   ARC    /.125
                   LN     /DX,-2.75
                   ARC    /.125
                   LN     /DY,-.125
                   LN     /0,1.562,DY,.625
                   ARC    /.125
                   LN     /DX,2.75
                   ARC    /.125
                   LN     /DY,-1.25
                   ARC    /.125
                   LN     /DX,-2.75
                   ARC    /.125
                   LN     /DY,.125
           CTRLN ,LN      /-.25,1.562,DX,2.75+.5
 L1       =CTRLN ,LN      /1.375,2.625+.5,DY,-3.125
 L2       =CTRLN ,LN      /1.375-.5,.5,DX,1
 L3       =CTRLN ,LN      /1.375-.5,2.625,DX,1
 P1       =        PT     /INTOF,L1,L2,,P2=PT/INTOF,L1,L3
                   CR     /P1,9/64
                   CR     /P1,.25
                   CR     /P2,9/64
 CO       =        CR     /P2,.25
 PW       =        PT     /YLARGE,INTOF,L1,CO
                   END    /TOP
                   ORIGIN/3,2.188
                   DRAW   /TOP
                   ALPHAP/(.1,.2,.1,0),(0,-.2,0,-15)
                          @ 82$DG$ X 1/2 DIA.@
 HOLE     =DOTTED,VIEW   /
                   LN     /0,.125,DX,2.75-1.875
                   LN     /2.75-1.875,0,DY,.25
                   LN     /DX,1.875-.625
                   LN     /2.75-.625,0,DY,5/16
                   LN     /DX,.625
           CONSTR,LN      /DY,-1/32
                   LN     /DX,-.625
                   END    /HOLE
                   ORIGIN/3,3.75
                   DRAW   /HOLE
                   DRAW   /MIRY(HOLE)
 SIDE     =        VIEW   /
 L4       =CTRLN ,LN      /-(.625+.25),0,DX,.625+1.187+.5
 L5       =CTRLN ,LN      /0,.625+.25,DY,-(.625*2+.5)
 P3       =        PT     /INTOF,L4,L5
                   CR     /P3,.125
```

```
                  CR      /P3,.25
C1       =        CR      /P3,.312-1/32
            DOTTED,CR     /P3,.312
                  ARC     /P3,.625,90,180
                  LN      /DX,1.187-.437
                  ARC     /.125
                  LN      /DY,-(1.562-.625)
P6       =        PT      /PPP
                  ARC     /.125
                  LN      /DX,.437
P7       =        PT      /PPP
                  LN      /DY,3.125/2
PFN      =        PT      /PPP,,PX=PT/YLARGE,INTOF,L5,C1
                  LN      /PFN,DY,3.125/2
                  LN      /DX,-.437
                  ARC     /.125
                  LN      /DY,-(1.562-.625)
                  ARC     /.125
                  LN      /DX,-(1.187-.437)
                  END     /SIDE
                  ORIGIN/7.875,3.75
                  DRAW    /SIDE
                  NOTER /PX,-.125,.75,@1/4 DRILL BORE 1/2@,$
                          @DIA. X 1 7/8 DP.@
                  NOTER /-5/8,0,-.25,.125,@5/8 R@
                  NOTE    /PFN,@$FN$@
                  MASK    /@P,F16@
                  DIMP    /2,.1,2,2
                  DIMST /YSMALL,XCOMP,P6,P7,.25
                  DIM     /P6,P7
CSINK    =DOTTED,VIEW     /
          CTRLN ,LN       /1.187-(.437+.25),1.062,DX,.437+.5
P5       =        LN      /1.187-.437,1.062+.25,ATANGL,139,$
                           TILLY,1.062+9/64
                  LN      /PPP,ATANGL,0,TILLX,1.187
                  LN      /1.187-.437,1.062-.25,ATANGL,221,$
                           TILLY,1.062-9/64
                  LN      /PPP,ATANGL,0,TILLX,1.187
                  LN      /(POINT/P5),DY,-9/32
                  END     /CSINK
                  ORIGIN/7.875,3.75
                  DRAW    /CSINK
                  DRAW    /MIRY(CSINK)
                  FINI    /
```



SKETCH 17

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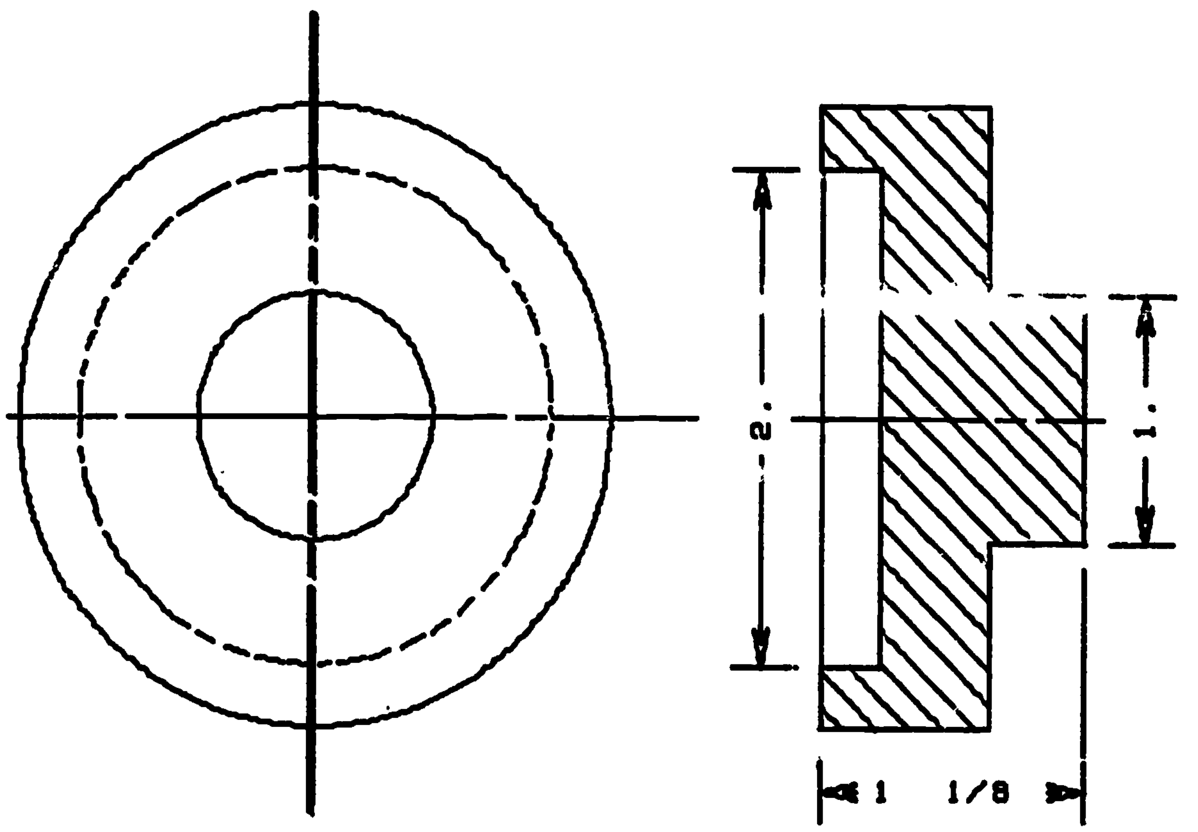

PLATE 17

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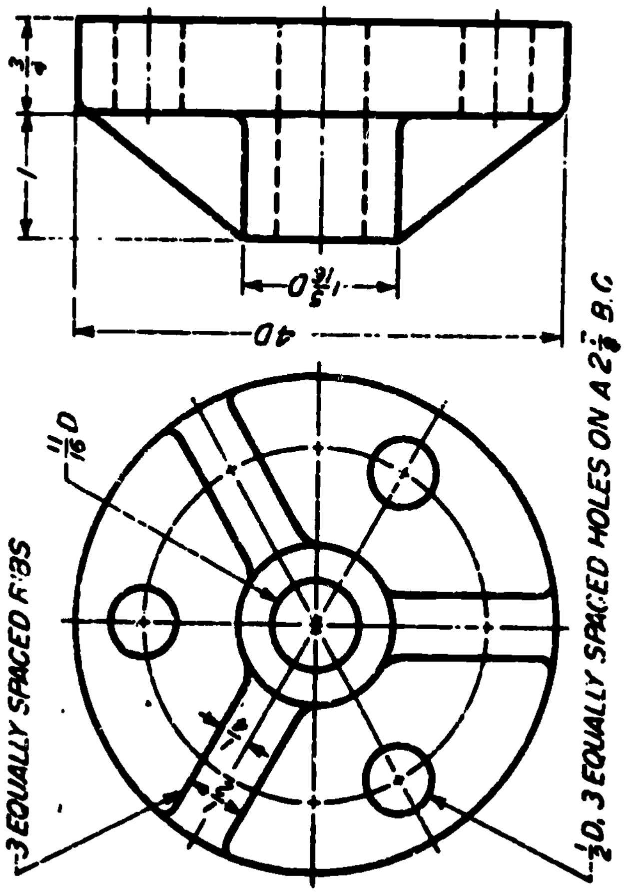
```
$$  PLATE 17         INTODUCTION TO CROSS HATCHING
 V1TOP   =          VIEW  /
                    ORIGIN/3.75,5.875
          CUTPL ,LINE  /0,-1.6,DY,3.2
          CTRLN ,LINE  /0,0,DX,-1.3
          CTRLN ,LINE  /0,0,DX,1.6
          CTRLN ,LINE  /2,0,DX,1.3
                 CIRCLE/0,0,.5
          DOTTED,CIRCLE/0,0,1
                 CIRCLE/0,0,1.25
                 END   /V1TOP
                 DRAW  /V1TOP
 V1SEC    =      VIEW  /
 P1       =      PT    /2.125,1
                 LINE  /P1 ,DY,.25
 P2       =      PT    /PPP
                 LINE  /PPP,DX,.7
 P3       =      PT    /PPP
                 LINE  /PPP,DY,-.75
                 LINE  /PPP,DX,.4
 P4       =      PT    /PPP
 L1       =      LINE  /PPP,DY,-1
 P5       =      PT    /PPP
                 LINE  /PPP,DX,-.4
                 LINE  /PPP,DY,-.75
 P6       =      PT    /PPP
 L3       =      LINE  /PPP,DX,-.7
 P7       =      PT    /PPP
                 LINE  /PPP,DY,.25
 P8       =      PT    /PPP
                 LINE  /PPP,DX,.25
 P9       =      PT    /PPP
                 LINE  /PPP,DY,2
 P10      =      PT    /PPP
 L4       =      LINE  /PPP,P1
                 END   /V1SEC
                 DRAW  /V1SEC
                 HATCHP/135,.1,0,0
                 HATCH /V1SEC
                 MASK  /@PF08TN@
                 DIMST /XLARGE,YCOMP,L1,.25
                 DIMP  /.5,.1,1,1
                 DIM   /P5,P4
                 MASK  /@PF00TN@
                 DIMST /XSMALL,YCOMP,P1,P8,.25
                 DIM   /P1,P8
                 MASK  /@PF16TN@
                 DIMST /YSMALL,XCOMP,L3,.25
                 DIMP  /L3
                 DIMP  /.5,.1,1,1
                 DIM   /P7,P5
 V        =      VIEW  /
```

```
LINE  /P1,DY,-2
END   /V
DRAW  /V
FINI  /
```



SKETCH 18

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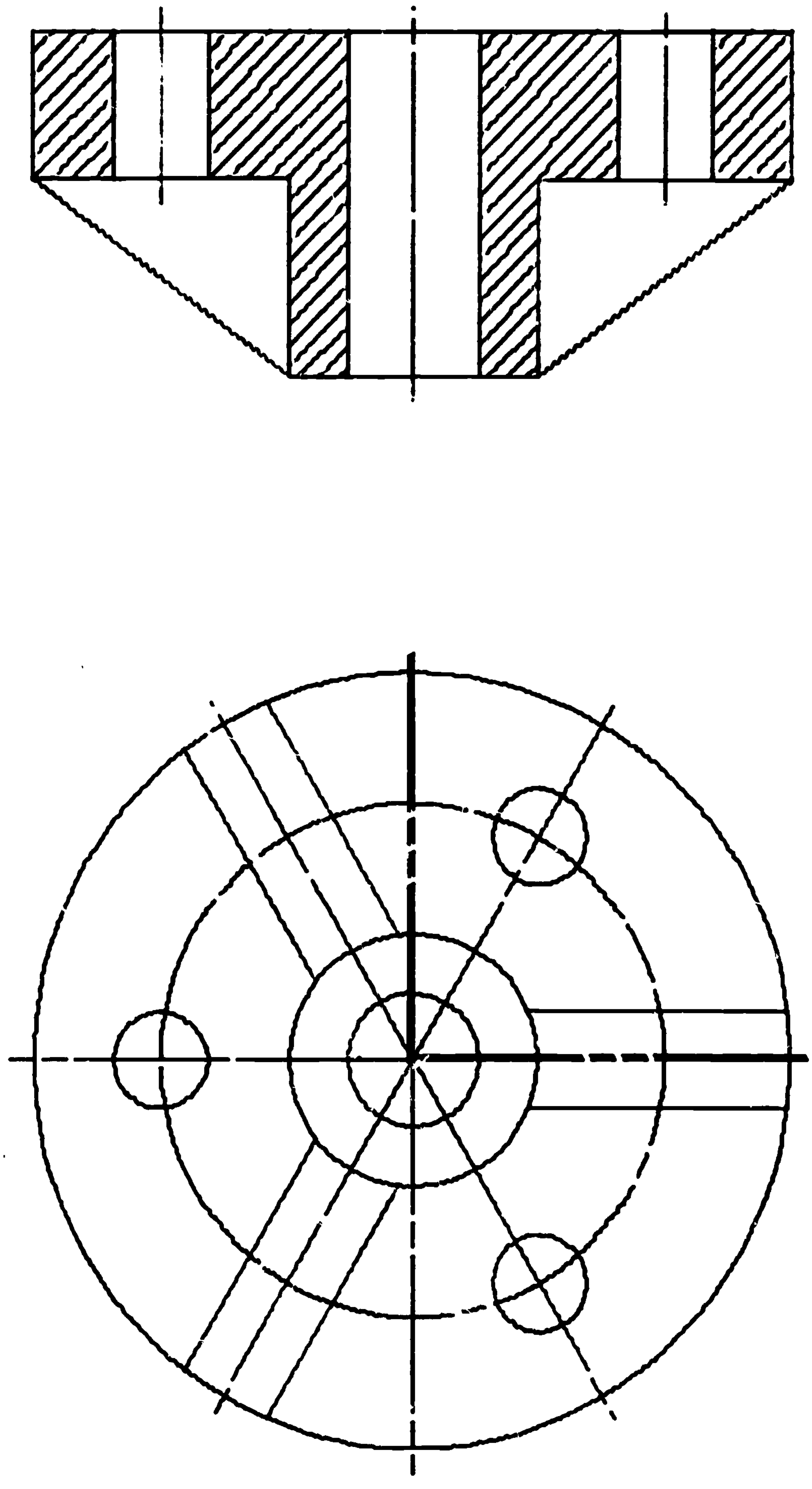

PLATE 18

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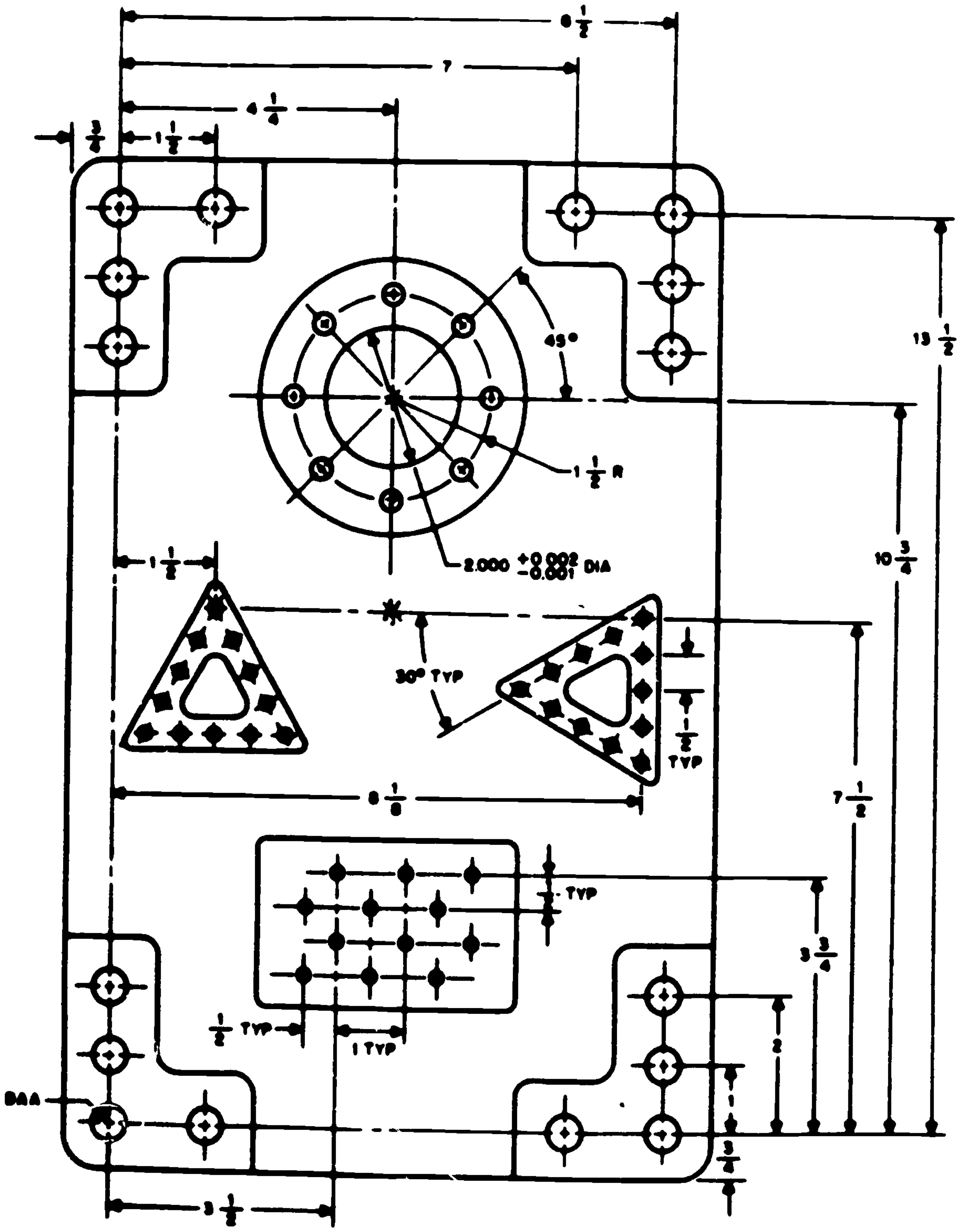
```
$$  PLATE 18            HATCHING A SHAFT GUIDE    (LONG -X-)
                    ALPHAP/(.2,.2,0,-.2),(0,0,0,270)
                    TITLE /1.5,2.5,@PLATE 18@
  SHAFT    =        VIEW  /
                    ORIGIN/4.25,3.75
  C1       =        CR    /0,0,11/32
  C2       =        CR    /0,0,21/32
  C3       =        CR    /0,0,2
  C4       =CTRLN ,CR     /0,0,1+21/64
  CNTERY   =CUTPL ,LN     /0,0,ATANGL,270,LENGTH,2.125
  LNR      =CONSTR,LN     /XLARGE,PARLEL,CNTERY,.25
  LNL      =CONSTR,LN     /XSMALL,PARLEL,CNTERY,.25
  PRR1     =        PT    /YSMALL,INTOF,LNR,C2
  PRR2     =        PT    /YSMALL,INTOF,LNR,C3
  PRL1     =        PT    /YSMALL,INTOF,LNL,C2
  PRL2     =        PT    /YSMALL,INTOF,LNL,C3
                    LN    /PRR1,PRR2
                    LN    /PRL2,PRL1
                    LOOPST/
  N=30
1)CNTER1   =CTRLN ,LN     /0,0,ATANGL,N,LENGTH,2.125
  LNRIGT   =CONSTR,LN     /XLARGE,PARLEL,CNTER1,.25
  PRGT1    =        PT    /YLARGE,INTOF,LNRIGT,C2
  PRGT2    =        PT    /YLARGE,INTOF,LNRIGT,C3
                    LN    /PRGT1,PRGT2
  N=N+120
  IF(N-150)1,1,2
  2)                LOOPND/
                    LOOPST/
  N=30
1)CNTERX   =CONSTR,LN     /0,0,ATANGL,N,LENGTH,2.125
  LNLEFT   =CONSTR,LN     /XSMALL,PARLEL,CNTERX,.25
  PLFT1    =        PT    /YLARGE,INTOF,LNLEFT,C2
  PLFT2    =        PT    /YLARGE,INTOF,LNLEFT,C3
                    LN    /PLFT1,PLFT2
  N=N+120
  IF(N-150)1,1,2
  2)                LOOPND/
                    LOOPST/
  N=210
1)L3       =CTRLN ,LN     /0,0,ATANGL,N,LENGTH,2.125
  P5       =        PT    /YSMALL,INTOF,L3,C4
                    CR    /P5,.25
  N=N+120
  IF(N-330)1,1,2
  2)                LOOPND/
  LX4      =CTRLN ,LN     /0,0,ATANGL,90,LENGTH,2.125
  PX6      =        PT    /YLARGE,INTOF,LX4,C4
                    CR    /PX6,.25
           CTRLN ,LN      /0,0,DX,-2.125
           CUTPL ,LN      /0,0,DX,2.125
                    END   /SHAFT
```

```
                    DRAW    /SHAFT
SHAFT1    =         VIEW    /
                    LN      /3.5,21/32,DY,-21/16
P1        =         PT      /PPP
                    LN      /PPP,DX,1
P2        =         PT      /PPP
                    LN      /PPP,DY,-(2-21/32)
P3        =         PT      /PPP
                    LN      /PPP,DX,3/4
P4        =         PT      /PPP
                    LN      /PPP,DY,4
P5        =         PT      /PPP
                    LN      /PPP,DX,-3/4
P6        =         PT      /PPP
                    LN      /PPP,DY,-(2-21/32)
P7        =         PT      /PPP
                    LN      /PPP,DX,-1
P8        =         PT      /PPP
P9        =         PT      /3.5,11/32
                    LN      /P9,DX,1.75
P10       =         PT      /PPP
              CONSTR,LN     /PPP,DY,-11/16
P11       =         PT      /PPP
                    LN      /P11,DX,-1.75
P12       =         PT      /PPP
                    LN      /P1,P3
P13       =         PT      /4.5,-(1.75-43/64)
                    LN      /P13,DX,.75
P14       =         PT      /PPP
              CONSTR,LN     /P14,DY,-.5
P15       =         PT      /PPP
                    LN      /P15,DX,-.75
P16       =         PT      /PPP
P17       =         PT      /4.5,(1.75-43/64)
                    LN      /P17,DX,.75
P18       =         PT      /PPP
              CONSTR,LN     /P18,DY,.5
P19       =         PT      /PPP
                    LN      /P19,DX,-.75
P20       =         PT      /PPP
                    LN      /P6,P8
              CTRLN ,LN     /3.375,0,DX,2.0
              CTRLN ,LN     /4.375,-(2-43/64),DX,1.0
              CTRLN ,LN     /4.375,(2-43/64),DX,1.0
                    END     /SHAFT1
                    DRAW    /SHAFT1
SHAFT2    =         VIEW    /
              CONSTR,LN     /P15,P16
              CONSTR,LN     /P16,P3
              CONSTR,LN     /P3,P4
              CONSTR,LN     /P4,P15
              CONSTR,LN     /P10,P18
              CONSTR,LN     /P18,P17
              CONSTR,LN     /P17,P7
              CONSTR,LN     /P7,P8
```

```
          CONSTR,LN    /P8,P9
          CONSTR,LN    /P9,P10
                 END   /SHAFT2
                 DRAW  /SHAFT2
                 HATCHP/135,.075,0,0
                 HATCH /SHAFT2
SHAFT3  =        VIEW  /
          CONSTR,LN    /P20,P19
          CONSTR,LN    /P19,P5
          CONSTR,LN    /P5,P6
          CONSTR,LN    /P6,P20
          CONSTR,LN    /P12,P11
          CONSTR,LN    /P11,P14
          CONSTR,LN    /P14,P13
          CONSTR,LN    /P13,P2
          CONSTR,LN    /P2,P1
          CONSTR,LN    /P1,P12
                 END   /SHAFT3
                 DRAW  /SHAFT3
                 HATCHP/135,.075,0,0
                 HATCH /SHAFT3
                 FINI  /
```



SKETCH 19

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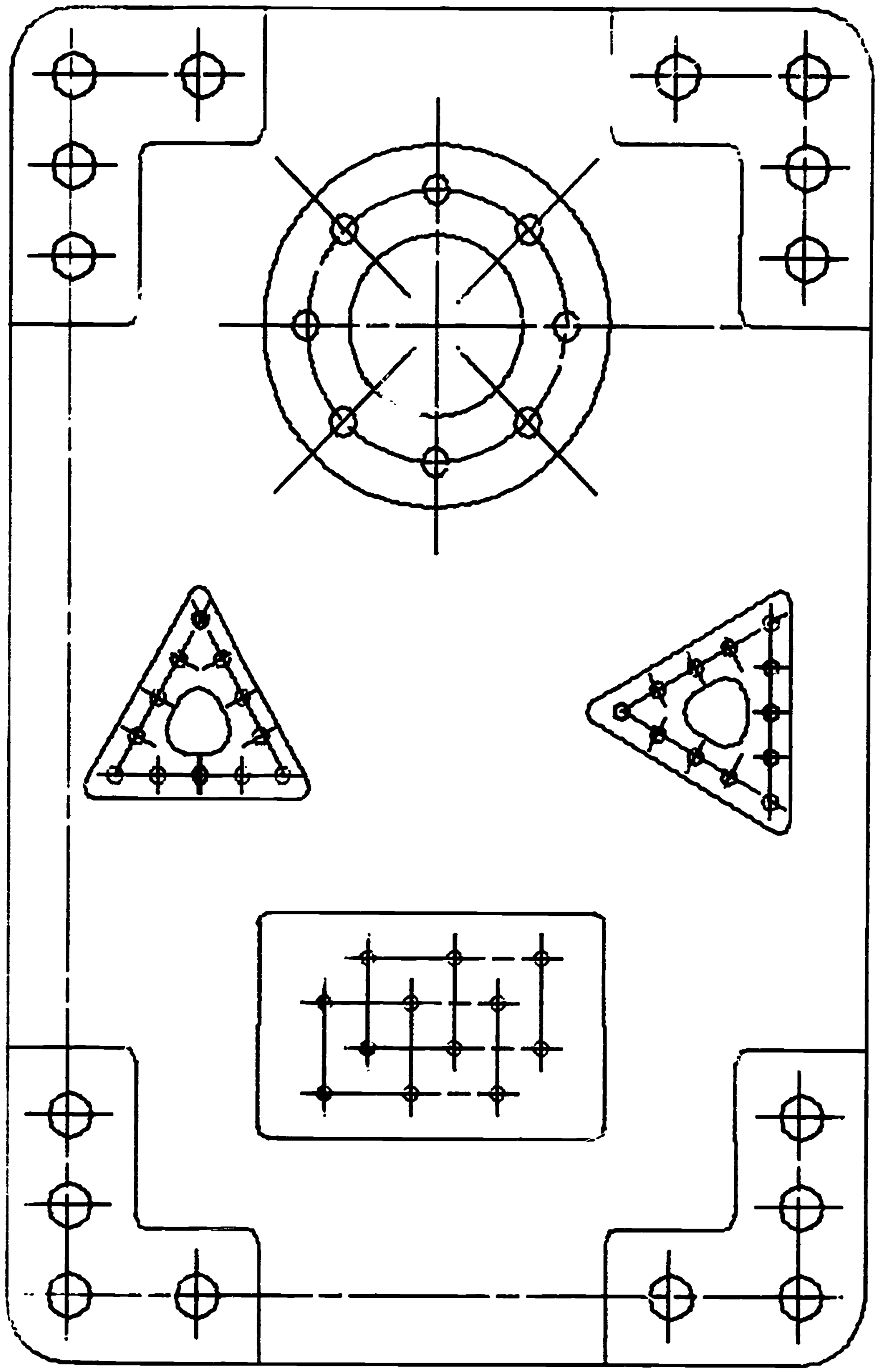

PLATE 19

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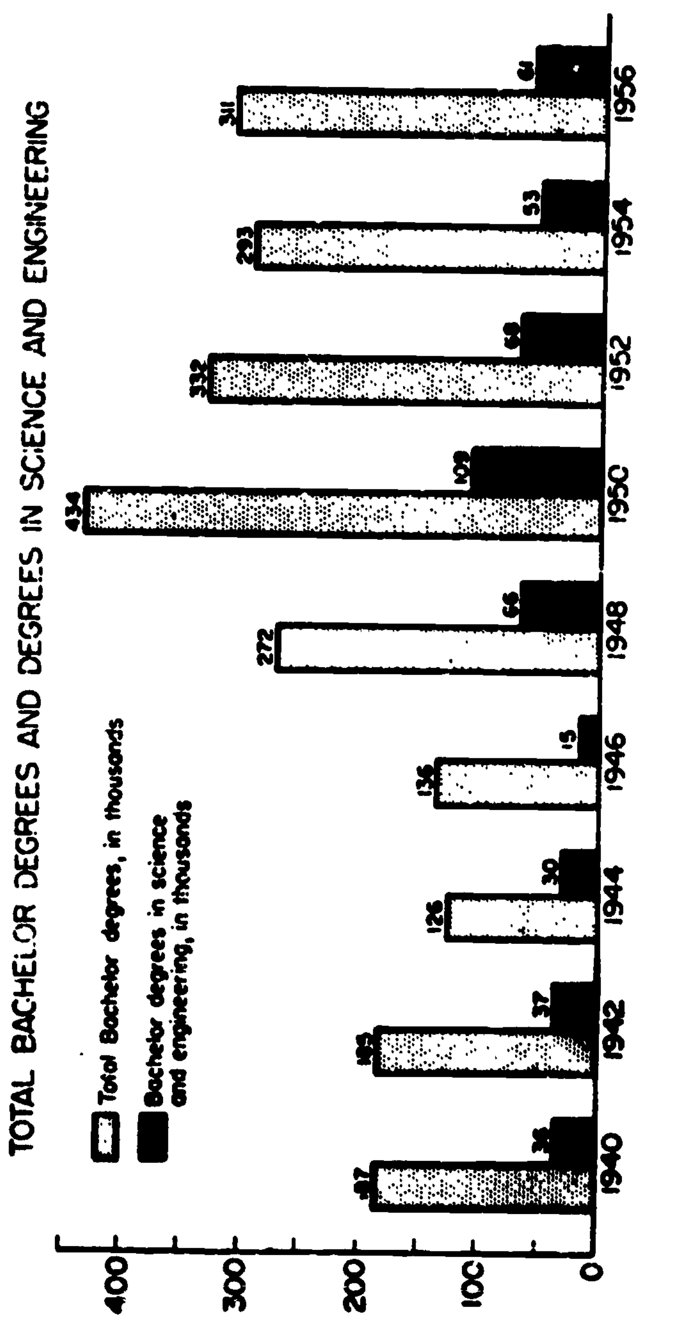
```
$$  PLATE 19              MOUNTING PLATE
                        ALPHAP/(.2,.2,.2,0),(0,0,0,0)
                        TITLE /6,1.5,@PLATE 19@
                        SCALE /.5
  FRAMEX  =             VIEW  /
                        LINE  /01,0,DX,9
                        ARC   /0.75
                        LINE  /DY,15
                        ARC   /0.75
                        LINE  /DX,-10
                        ARC   /0.75
                        LINE  /DY,-15
                        ARC   /0.75
                        LINE  /DX,1
                        END   /FRAMEX
                        ORIGIN/2.25,2.125
                        DRAW  /FRAMEX
  CORNER  =             VIEW  /
                        LINE  /2,7.5,DY,-1.50
                        ARC   /5/32
                        LINE  /DX,1.5
                        ARC   /5/32
                        LINE  /DY,-2
                        ARC   /5/32
                        LINE  /DX,1.5
                        END   /CORNER
                        ORIGIN/4.75,5.875
                        DRAW  /CORNER
                        DRAW  /MIRX(CORNER)
                        DRAW  /MIRY(CORNER)
                        DRAW  /MIRXY(CORNER)
  CHOLE   =CTRLN ,VIEW  /
                        LINE  /0,-.5,DY,14.5
                        LINE  /-.5,13.5,DX,2.5
                        LINE  /7-1/2,13.5,DX,2.5
                        LINE  /9,12.5,DX,-1
                        LN    /1/2,12.5,DX,-1
                        LN    /-1/2,11.5,DX,1
                        LN    /8,11.5,DX,1
                        LN    /9,2,DX,-1
                        LN    /1/2,2,DX,-1
                        LN    /-1/2,1,DX,1
                        LN    /8,1,DX,1
                        LN    /9,0,DX,-9.5
                        LN    /1.5,-1/2,DY,1
                        LN    /7,1/2,DY,-1
                        LN    /8.5,-1/2,DY,3
                        LN    /8.5,11,DY,3
                        LN    /7,14,DY,-1
                        LN    /1.5,13,DY,1
                        END   /CHOLE
                        ORIGIN/2.615,2.5
```

```
                    DRAW   /CHOLE
SMLCIR   =          VIEW   /
                    ORIGIN/4.75,5.875
                    CIRCLE/4.25,6.75,.25
                    CIRCLE/4.25,5.75,.25
                    CIRCLE/4.25,4.75,.25
                    CIRCLE/2.75,6.75,.25
                    END    /SMLCIR
                    DRAW   /SMLCIR
                    DRAW   /MIRX(SMLCIR)
                    DRAW   /MIRY(SMLCIR)
                    DRAW   /MIRXY(SMLCIR)
LGCIR    =          VIEW   /
                    ORIGIN/4.75,7.875
                    CIRCLE/0,0,1.
                    CIRCLE/0,0,2.
  C1     =CTRLN ,CIRCLE/0,0,1.5
          CTRLN ,LN     /0,-2.5,DY,5.
          CTRLN ,LN     /-2.5,0,DX,6.
                    END    /LGCIR
                    DRAW   /LGCIR
LGCIRL   =          VIEW   /
                    ORIGIN/4.75,7.875
  L1     =CTRLN ,LN     /.25,.25,ATANGL,45,LENGTH,2.25
                    END    /LGCIRL
                    DRAW   /LGCIRL
                    DRAW   /MIRX(LGCIRL)
                    DRAW   /MIRY(LGCIRL)
                    DRAW   /MIRXY(LGCIRL)
  CIRMIR=           VIEW   /
                    ORIGIN/4.75,7.875
                    CIRCLE/(POINT/XLARGE,INTOF,L1,C1),.3125/2
                    END    /CIRMIR
                    DRAW   /CIRMIR
                    DRAW   /MIRX(CIRMIR)
                    DRAW   /MIRY(CIRMIR)
                    DRAW   /MIRXY(CIRMIR)
  CIRTOP=           VIEW   /
                    ORIGIN/3.75,7.875
                    CIRCLE/2,1.5,.3125/2
                    END    /CIRTOP
                    DRAW   /CIRTOP
                    DRAW   /MIRY(CIRTOP)
  CIRSID=           VIEW   /
                    ORIGIN/4.75,6.875
                    CIRCLE/1.5,2,.3125/2
                    END    /CIRSID
                    DRAW   /CIRSID
                    DRAW   /MIRX(CIRSID)
  BOX    =          VIEW   /
                    ORIGIN/2.615,2.5
                    LN     /2.375,1.750,DX,3.875
                    ARC    /.125
                    LN     /DY,2.5
                    ARC    /.125
```

```
                LN     /DX,-4.
                ARC    /.125
                LN     /DY,-2.5
                ARC    /.125
                LN     /DX,.125
         CTRLN ,LN     /2.75,2.25,DX,2.5
         CTRLN ,LN     /2.75,3.25,DX,2.5
         CTRLN ,LN     /3.25,2.75,DX,2.5
         CTRLN ,LN     /3.25,3.75,DX,2.5
                END    /BOX
                DRAW   /BOX
BOXCIR=         VIEW   /
                ORIGIN/3.75,4.125
                CIRCLE/1.25,.5,.152/2
                CIRCLE/2.25,.5,.152/2
                CIRCLE/3.25,.5,.152/2
                LN     /1.25,.75,DY,-.75
                LN     /2.25,.75,DY,-.75
                LN     /3.25,.75,DY,-.75
                END    /BOXCIR
                DRAW   /BOXCIR
                DRAW   /MIRY(BOXCIR)
BIXSIR=         VIEW   /
                ORIGIN/3.75,3.875
                CIRCLE/.75,.5,.152/2
                CIRCLE/1.75,.5,.152/2
                CIRCLE/2.75,.5,.152/2
                LN     /.75,.75,DY,-.75
                LN     /1.75,.75,DY,-.75
                LN     /2.75,.75,DY,-.75
                END    /BIXSIR
                DRAW   /BIXSIR
                DRAW   /MIRY(BIXSIR)
LFTRI =         VIEW   /
                ORIGIN/3.375,5.3845
L2     =CTRLN ,LN     /0,0,DX,1.2
L3     =CTRLN ,LN     /1,0,ATANGL,120,TILLX,-.173
        CONSTR,LN     /1,0,ATANGL,320,TILLY,-.1
                LN     /0,-.2,DY,.4
                LN     /.5,-.2,DY,.4
                CR     /0,0,.164/2
                CR     /.5,0,.164/2
                CR     /1,0,.164/2
L4     =CONSTR,LN     /-.5,0,ATANGL,60,TILLY,7.5
L5     =CONSTR,LN     /0,0,ATANGL,60,TILLY,7.5
L6     =CONSTR,LN     /.5,0,ATANGL,60,TILLY,7.5
                CR     /(POINT/XLARGE,INTOF,L3,L4),.164/2
                CR     /(POINT/XLARGE,INTOF,L3,L5),.164/2
                CR     /(POINT/XLARGE,INTOF,L3,L6),.164/2
                CR     /0,SQRT(3),.164/2
        CONSTR,LN     /(POINT/XLARGE,INTOF,L3,L4),ATANGL,$
                        30,TILLX,.423
                LN     /PPP,ATANGL,210,TILLX,.047
        CONSTR,LN     /(POINT/XLARGE,INTOF,L3,L5),ATANGL,$
                        30,TILLX,.673
```

```
                LN      /PPP,ATANGL,210,TILLX,.327
         CONSTR,LN      /(POINT/XLARGE,INTOF,L3,L6),ATANGL,$
                         30,TILLX,.923
                LN      /PPP,ATANGL,210,TILLX,.547
                END     /LFTRI
                DRAW    /LFTRI
                DRAW    /MIRX(LFTRI)
LFFIN=          VIEW    /
                ORIGIN/2.615,2.5
                LN      /.5,5.517,DX,2.4325
                ARC     /.125
                LN      /PPP,ATANGL,120,TILLX,1.5
                ARC     /.125
                LN      /PPP,ATANGL,240,TILLY,5.517
                ARC     /.125
                LN      /DX,.55
                LN      /1.333,6.017,DX,.7345
                ARC     /.25
                LN      /PPP,ATANGL,120,TILLX,1.5
                ARC     /.25
                LN      /PPP,ATANGL,240,TILLY,6.017
                ARC     /.25
                LN      /DX,.4005
                END     /LFFIN
                DRAW    /LFFIN
RGTRI =         VIEW    /
                ORIGIN/5.82135,5.75
L7     =CTRLN   ,LN     /0,0,ATANGL,30,TILLY,1.1
L8     =CTRLN   ,LN     /SQRT(3),1.2,DY,-1.2
                CR      /0,0,.082
L9     =        LN      /.3325,.423,ATANGL,300,TILLX,.5325
                CR      /(POINT/XLARGE,INTOF,L7,L9),.082
L10    =        LN      /.765,.673,ATANGL,300,TILLX,.965
                CR      /(POINT/XLARGE,INTOF,L7,L10),.082
L11    =        LN      /1.1975,.823,ATANGL,300,TILLX,1.3975
                CR      /(POINT/XLARGE,INTOF,L7,L11),.082
                CR      /(POINT/XLARGE,INTOF,L7,L8),.082
L12    =        LN      /SQRT(3)-.2,.5,DX,.4
                CR      /(POINT/XLARGE,INTOF,L8,L12),.082
L13    =        LN      /SQRT(3)-.2,0,DX,.4
                CR      /(POINT/XLARGE,INTOF,L8,L13),.082
                END     /RGTRI
                DRAW    /RGTRI
                DRAW    /MIRY(RGTRI)
RGFIN =         VIEW    /
                ORIGIN/2.615,2.5
                LN      /6.3927,6.5+.25/SIND(60),ATANGL,30,$
                         TILLX,8.375
                ARC     /.125
                LN      /DY,-2.865
                ARC     /.125
                LN      /PPP,ATANGL,150,TILLY,6.5
                ARC     /.125
                LN      /PPP,ATANGL,30,TILLX,6.3927
                LN      /7.25,.3575*SIND(30)/COSD(30)+6.5,$
```

```
        ATANGL,30,TILLX,7.875
ARC    /.25
LN     /PPP,ATANGL,270,TILLY,$
        .25*COSD(30)/SIND(30)+5.5
ARC    /.25
LN     /PPP,ATANGL,150,TILLX,6.8927
ARC    /.25
LN     /PPP,ATANGL,30,TILLX,7.2500
END    /RGFIN
DRAW   /RGFIN
FINI/
```



SKETCH 20

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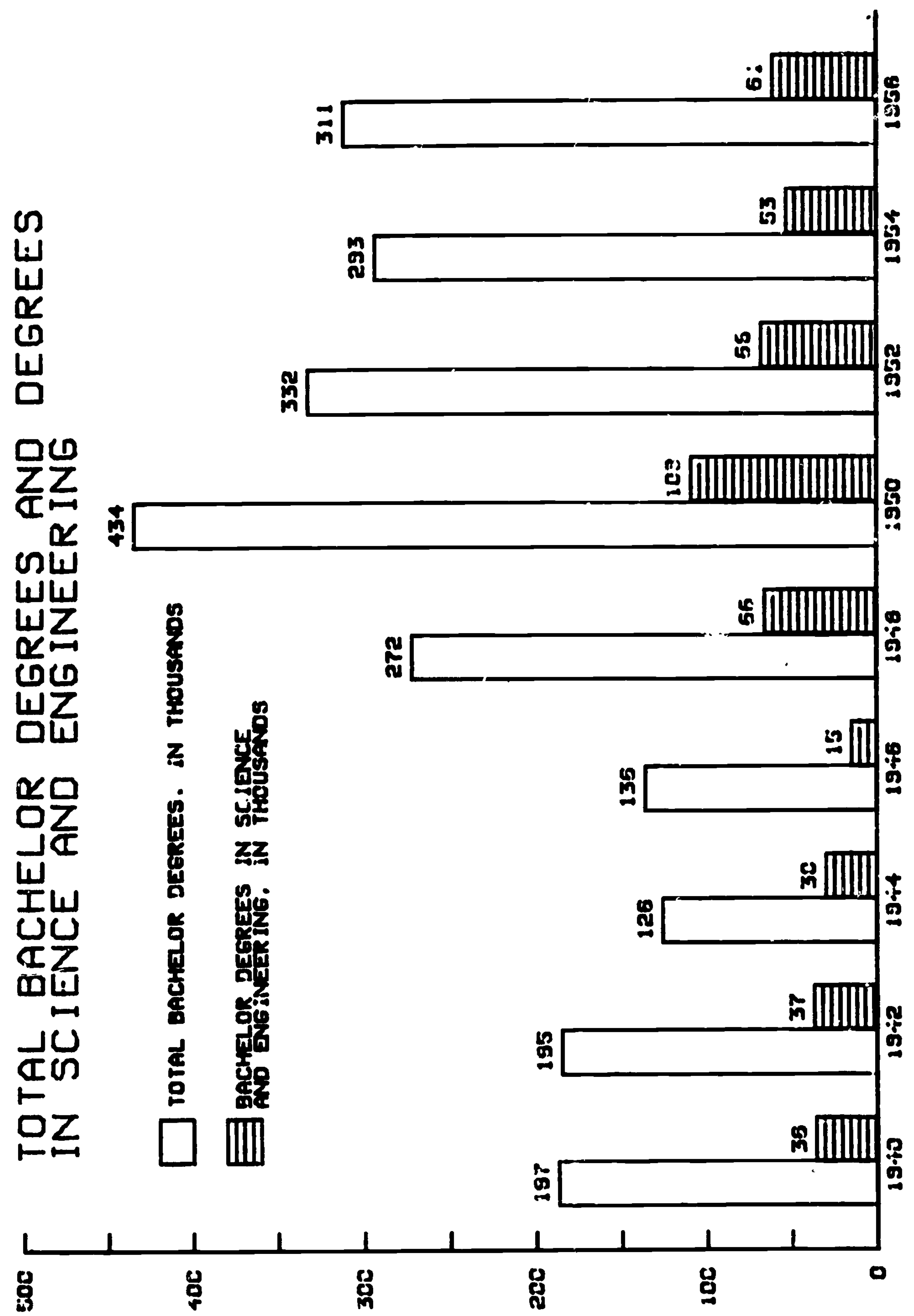

PLATE 20

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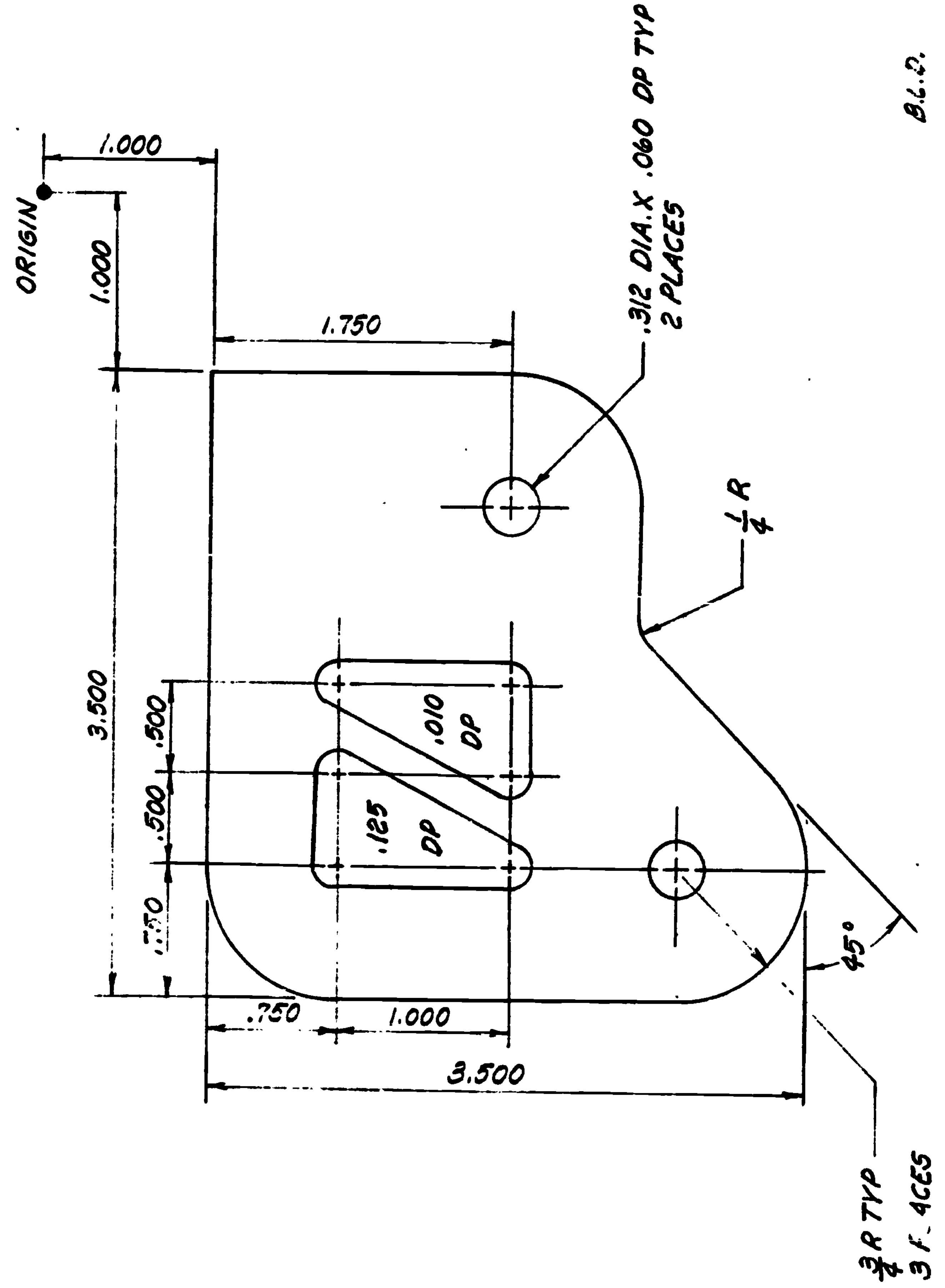
MIAMI-DADE JUNIOR COLLEGE

```
$$PLATE 20          BAR GRAPH USING TWO MACROS
CALL/REFAX,,XLEN=7,,YLEN=5.,XUN=0,,YUN=.5,,OR=PT/2.5,1.5
ALPHAP/(.2,.2,.16,0),(0,-.2,0,0)
NOTE/.55,4.95,@TOTAL BACHELOR DEGREES AND DEGREES@,$
@IN SCIENCE AND ENGINEERING@
CALL/RECT,,X=.25,,Y=1.87,,ORX=.375,,OPT=0,,F=.1,,N=3,,LIT=@187@
CALL/RECT,,Y=1.85,,ORX=1.125,,LIT=@185@
CALL/RECT,,Y=1.26,,ORX=1.875,,LIT=@126@
CALL/RECT,,Y=1.36,,ORX=2.625,,LIT=@136@
CALL/RECT,,Y=2.72,,ORX=3.375,,LIT=@272@
CALL/RECT,,Y=4.34,,ORX=4.125,,LIT=@434@
CALL/RECT,,Y=3.32,,ORX=4.875,,LIT=@332@
CALL/RECT,,Y=2.93,,ORX=5.625,,LIT=@293@
CALL/RECT,,Y=3.11,,ORX=6.375,,LIT=@311@
CALL/RECT,,Y=.61,,ORX=6.625,,OPT=1,,N=2,,LIT=@61@
CALL/RECT,,Y=.53,,ORX=5.875,,LIT=@53@
CALL/RECT,,Y=.68,,ORX=5.125,,LIT=@68@
CALL/RECT,,Y=1.09,,ORX=4.375,,N=3,,LIT=@109@
CALL/RECT,,Y=.66,,ORX=3.625,,N=2,,LIT=@66@
CALL/RECT,,Y=.15,,ORX=2.875,,LIT=@15@
CALL/RECT,,Y=.3,,ORX=2.125,,LIT=@30@
CALL/RECT,,Y=.37,,ORX=1.375,,LIT=@37@
CALL/RECT,,Y=.36,,ORX=.625,,LIT=@36@
ALPHAP/(.1,.1,.08,0),(0,0,0,0)
NOTE/-.3,0,@  0@
NOTE/-.3,1,@100@
NOTE/-.3,2,@200@
NOTE/-.3,3,@300@
NOTE/-.3,4,@400@
NOTE/-.3,5,@500@
NOTE/.35,-.1,@1940@
NOTE/1.1,-.1,@1942@
NOTE/1.85,-.1,@1944@
NOTE/2.6,-.1,@1946@
NOTE/3.35,-.1,@1948@
NOTE/4.1,-.1,@1950@
NOTE/4.85,-.1,@1952
NOTE/5.6,-.1,@1954@
NOTE/6.35,-.1,@1956@
ORIGIN/2.5,5.1
CALL/RECT,,Y=.2,,ORX=.625,,N=0
ALPHAP/(.1,.1,.08,0),(0,-.1,0,0)
NOTE/.85,.1,@BACHELOR DEGREES IN SCIENCE@,$
@AND ENGINEERING, IN THOUSANDS@
ORIGIN/2.5,5.5
CALL/RECT,,OPT=0
NOTE/.85,.1,@TOTAL BACHELOR DEGREES, IN THOUSANDS@
FINI/
```

```
REFAX=MACRO/XLEN,YLEN,XUN,YUN
DEFPT/OR
XYZ=VIEW/
ORIGIN/OR
XNOTCH=0
YNOTCH=0
LN/DY,YLEN
LN/DY,-YLEN
LN/DX,XLEN
LN/DX,-XLEN
LOOPST/
IF(YUN)2,2,1
1) YNOTCH=YNOTCH+YUN
LN/0,YNOTCH,DX,YUN/5
IF(YNOTCH-YLEN)1,2,2
2) IF(XUN)4,4,3
3) XNOTCH=XNOTCH+XUN
LN/XNOTCH,0,DY,-XUN/5
IF(XNOTCH-XLEN)3,4,4
4) LOOPND
END/XYZ
DRAW/XYZ
TERMAC/
```

```
RECT=MACRO/ORX,X,Y,OPT,N,F
DEFLT/LIT
ABC=VIEW/
REFSYS/ORX-X/2,0
LN/DY,Y
LN/,DX,X
LN/DY,-Y
LN/DX,-X
END/ABC
DRAW/ABC
ALPHAP/(F,F,.8*F,0),(0,0,0,0)
LOOPST/
IF(N)9,9,0
0) NOTE/X/2-.8*F*(N-1)/2,Y+F,LIT
9) IF(OPT)4,4,1
1) IF(OPT-1)4,2,3
2) HATCHP/0,.05,0,0
HATCH/ABC
JUMPTO/4
3) IF(OPT-2) 4,5,6
5) HATCHP/45,.05,0,0
HATCH/ABC
JUMPTO/4
6) IF(OPT-3)4,7,4
7) HATCHP/90,.05,0,0
HATCH/ABC
4) LOOPND
   REFSYS/NOMORE
TERMAC/
```



SKETCH 21

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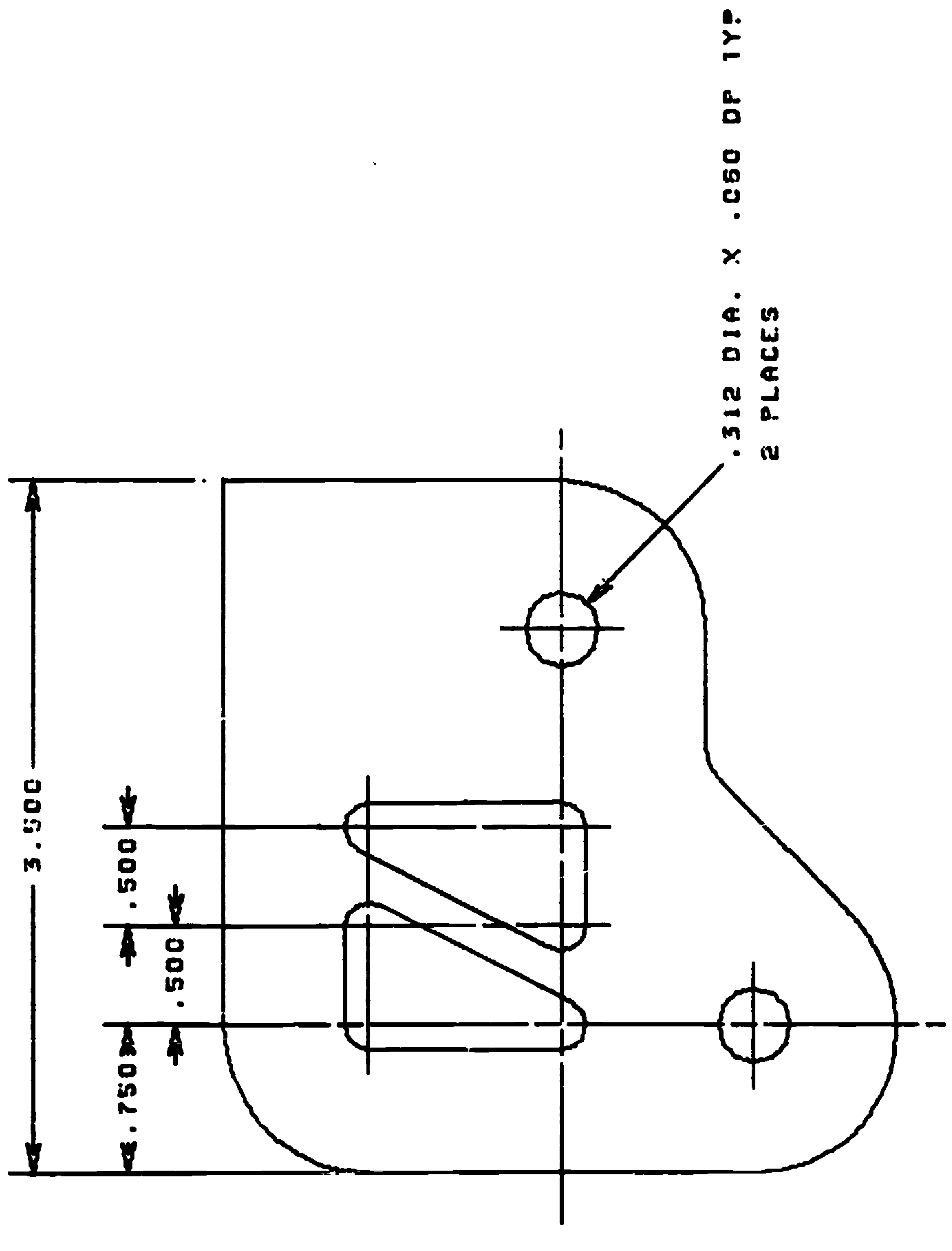

PLATE 21

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MIAMI-DADE JUNIOR COLLEGE

*** 1967 SUMMER INSTITUTE

```
$$  PLATE 21        CONTINUOUS PATH MILLING
  BOX       =       VIEW  /
CALL/FRAME1,,X=10,,Y=6.5,,ORX=.5,,ORY=.5
                    END   /BOX
                    DRAW  /BOX
                    ALPHAP/(.2,.2,0,-.2),(0,0,0,270)
                    TITLE /1.5,2.5,@PLATE 21@
                    ORIGIN/8.69,6.5
  FRAME1    =       VIEW  /
  P17       =       PT    /-4.5,-1.69
  P18       =       PT    /-3.75,-1
  P19       =       PT    /-3.25,-1.625
  P20       =       PT    /-2.75,-1.625
  P0        =       PT    /-1,-1
  L3        =       LN    /P0,DX,-3.5
                    ARC   /.75
                    LN    /DY,-2.75
                    ARC   /-3.75,-3.75,.75,180,135
  P1        =       PT    /PPP
                    LN    /P0,DY,-1.75
  P4        =       PT    /PPP
                    ARC   /-1.75,-2.75,.75,0,-90
  P2        =       PT    /PPP
  L1        =CONSTR,LN    /P2,DX,-1
  L2        =CONSTR,LN    /P1,ATANGL,45,LENGTH,2
  P3        =       PT    /INTOF,L1,L2
                    LN    /P1,P3
                    ARC   /.25
                    LN    /P3,P2
                    END   /FRAME1
                    DRAW  /FRAME1
                    ORIGIN/8.69,6.5
  CONCIR    =       VIEW  /
  C5        =CONSTR,CIRCLE/-3.75,-1.75,.125
  C6        =CONSTR,CIRCLE/-3.75,-2.75,.125
  C7        =CONSTR,CIRCLE/-3.25,-1.75,.125
  C8        =CONSTR,CIRCLE/-3.25,-2.75,.125
  C9        =CONSTR,CIRCLE/-2.75,-2.75,.125
  C10       =CONSTR,CIRCLE/-2.75,-1.75,.125
  P5        =       PT    /-3.875,-2.25
  P6        =       PT    /-2.625,-2.25
                    LN    /P5,RIGHT,TANTO,C6
                    ARC   /.125
                    LN    /RIGHT,TANTO,C6,RIGHT,TANTO,C7
                    ARC   /.125
                    LN    /RIGHT,TANTO,C7,RIGHT,TANTO,C5
                    ARC   /.125
                    LN    /-3.875,-1.75,P5
                    LN    /P6,LEFT,TANTO,C9
                    ARC   /.125
                    LN    /LEFT,TANTO,C9,LEFT,TANTO,C8
                    ARC   /.125
```

```
                LN     /LEFT,TANTO,C8,LEFT,TANTO,C10
                ARC    /.125
                LN     /-2.625,-1.75,P6
                CIRCLE/-1.75,-2.75,.187
                CIRCLE/-3.75,-3.75,.187
P11      =      PT     /-4.75,-2.75
         CTRLN ,LN     /P11,DX,4
P12      =      PT     /-4.062,-3.75
         CTRLN ,LN     /P12,DX,.624
P13      =      PT     /-4,-1.75
         CTRLN ,LN     /P13,DX,1.5
P14      =      PT     /-3.75,-.75
         CTRLN ,LN     /P14,DY,-4
P15      =      PT     /-2.75,-1.5
         CTRLN ,LN     /P15,DY,-1.5
P16      =      PT     /-1.75,-2.438
         CTRLN ,LN     /P16,DY,-.624
         CTRLN,LN      /-3.25,-1.5,DY,-1.5
                END    /CONCIR
                DRAW   /CONCIR
                DIMST /YLARGE,XCOMP,L3,.5
                DIMP   /.5,.1,1,1
                MASK   /@PD3TN@
                DIM    /P17,P18
                DIMST /YLARGE,XCOMP,L3,.5
                DIMP   /.5,.1,2,2
                DIM    /P19,P20
                DIMST /YLARGE,XCOMP,L3,.25
                DIMNN /P18,P19
                DIMST /YLARGE,XCOMP,L3,1
                DIMP   /.5,.1,1,1
                DIM    /L3
                ALPHAP/(.1,.1,.1,0),(0,-.2,0,0)
                NOTE   /-1.75+(SQRT(2)/2)*.187,-2.75-(SQRT(2)/2)*.187,$
                .75,-.75,@.312 DIA. X .060 DP TYP@,@2 PLACES@
                FINI   /
```

NUMERICAL CONTROL

DETAILED OUTLINE OF PRESENTATION

THE COMPUTER'S ROLE IN NUMERIC CONTROL

A. INTRODUCTION

1. The Part Programmer's Qualifications and Responsibilities

   a. Qualifications: Blueprint Reading, Shop Practice, Analytic and Descriptive Geometry, Trigonometry.

   b. Responsibilities: Interpret engineering data, draft program manuscript, check output, correct errors.

   c. Preliminary planning: Select machine, optimize operations and approach, select tools and fixtures.

   d. Final development of complete plan: Initiate final design, write manuscript and operator instructions, check, revise.

2. Part Programming for Point-to-Point Positioning Machines.

   a. Job-shop conditions. Volume may justify computer.

   b. More complex machines. May demand computer.

   c. Using several machines. Heavy programming load manually.

   d. Higher speed machines. Have ability to produce more with computer.

   e. Increased utilization of machines. Possible through automated computation for sequential machining of several parts.

3. Part Programming for Contour Machining and Types of Programming Systems. Tool path on plane, tool related to path, shape to be machined.

4. Program Checking; Tape Verification. List, visual, dry run, plot.

5. Programming Languages - Popularity of use (1965 Data)

   a. AUTOSPOT 27.4%

   b. APT 19.2%

   c. AUTOPROPS 9.6%

   d. ADAPT 8.2%

   e. SPLIT 8.2%

   f. Others 27.4%

6. Design Automation

   a. Integration with numerical control.

b. Facilities for program processing: own, rent, share, terminal, service bureau.

B. INFORMATION PROCESSING AND STORAGE

1. Numerical codes.

2. Punched tapes.

3. Standardization of tapes. EIA R. S. 244 STANDARD 8 TRACK

4. Programming for numerical positioning control. Linear, rotary, combined, auxiliary functions.

5. Punched cards.

6. Equipment for punching and reading paper tapes. Punches, readers.

7. Magnetic tapes. Advantages, disadvantages, care.

8. Digital data-storage comparisons. Speeds, capacity, cost/bit, access rate.

C. THE AUTOSPOT II SYSTEM

1. General Application Description

a. Introduction and Sample Program. Autospot, though issued earlier, a condensed version of Westinghouse-IBM CAMP II.

b. The AUTOSPOT LANGUAGE

c. Vocabulary and Statements

1. Geometric.

2. Specification.

3. Machining. Major/minor/auxiliary.

4. Special.

d. Processor Organization.

2. Point-to-Point AUTOSPOT III Programming

a. AUTOSPOT III Definition Statements

1. Machine Axes.

2. DASHA

3. REMARK/TP.

4. REMARK.

b. AUTOSPOT Machining Statements

1. Symbol.
2. Major section.
3. Minor section.
4. Auxiliary section.

c. AUTOSPOT Special Statements

1. START.
2. FINI.

d. AUTOSPOT Punctuation

1. Equal sign.
2. Slash.
3. Parentheses.
4. Minus sign.
5. Decimal point.
6. Dollar sign.
7. Comma.

e. AUTOSPOT III Point-to-Point Operations

1. Operation words: SPDRL, CSK, DRILL, BORE, BOREOS, CBORE, REAM, TAP, are available on AUTOSPOT II.
2. Avoidance.
3. Manual and safe tool positions: cutter locations for tool and table position changes.
4. Dwell.

f. AUTOSPOT Patterns

1. Symbolic address.
2. Translation of patterns.
3. Reverse.
4. Invert.
5. THEN Connector and auxiliary section manipulation.

6. Higher level patterns.

g. AUTOSPOT III Routines

1. Bolt circle programming.

2. Incremented programming.

3. Except.

3. Numerical Control Laboratory

a. Processor Operation Instructions

1. Required programs.

2. Procedures.

3. Diagnostics.

b. Pratt & Whitney Tape-O-Matic Operation

1. Machine characteristics.

2. Control panel

3. Sequential steps.

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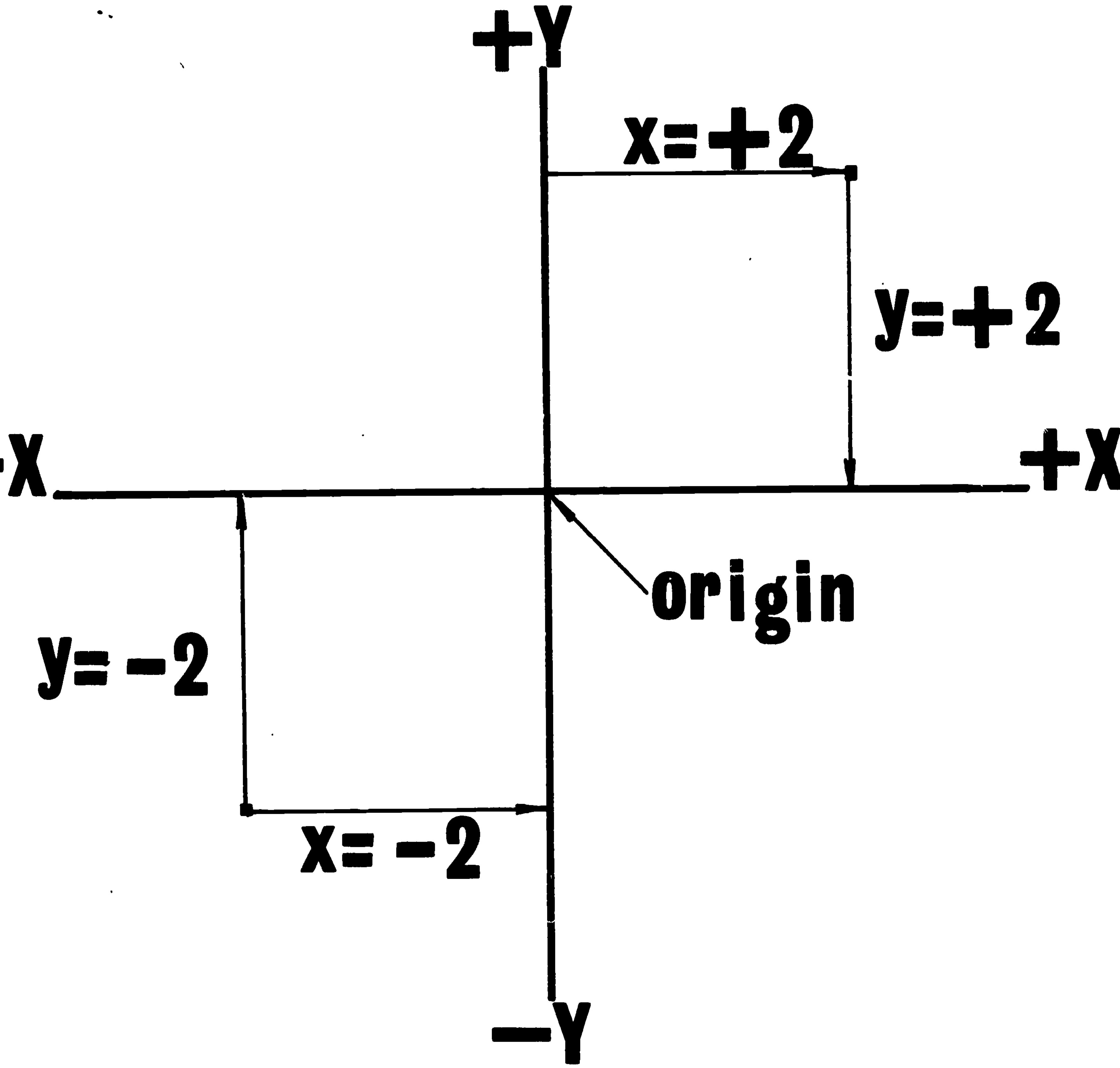
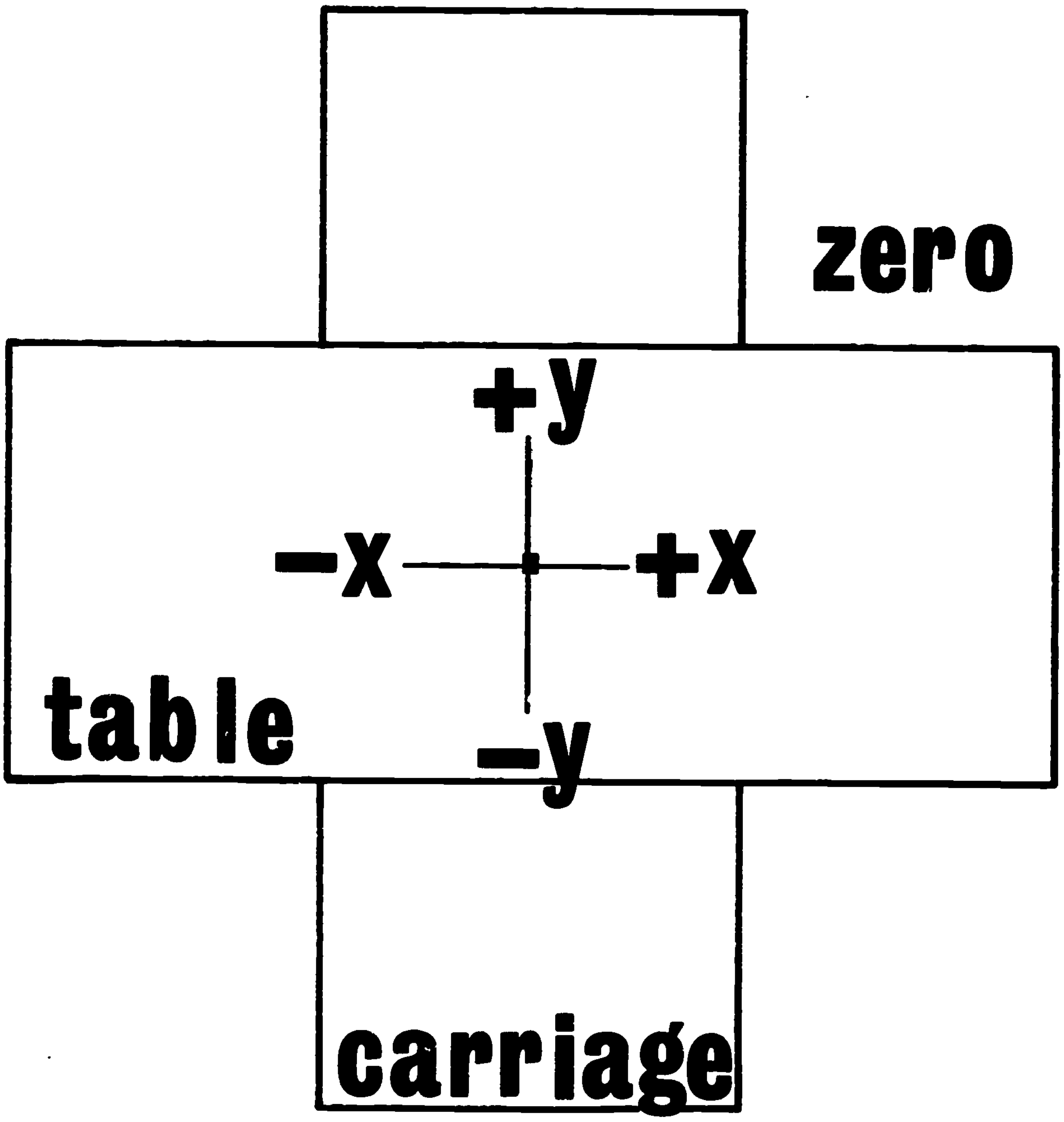
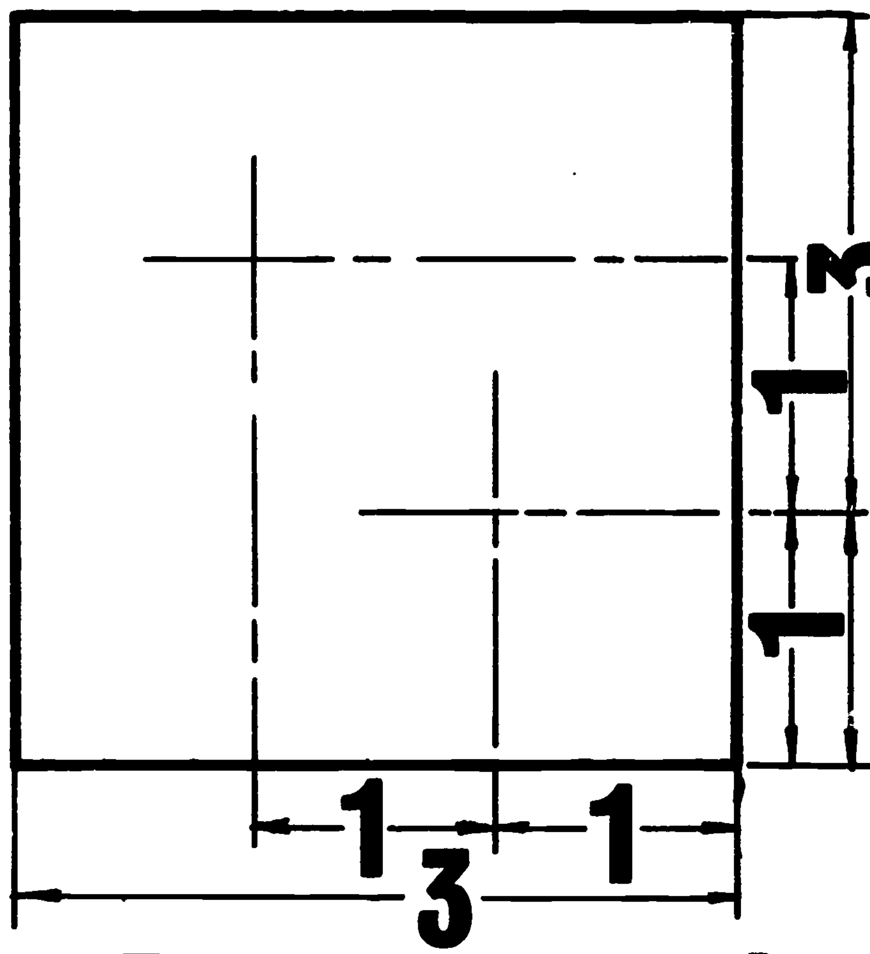
Coordinate System



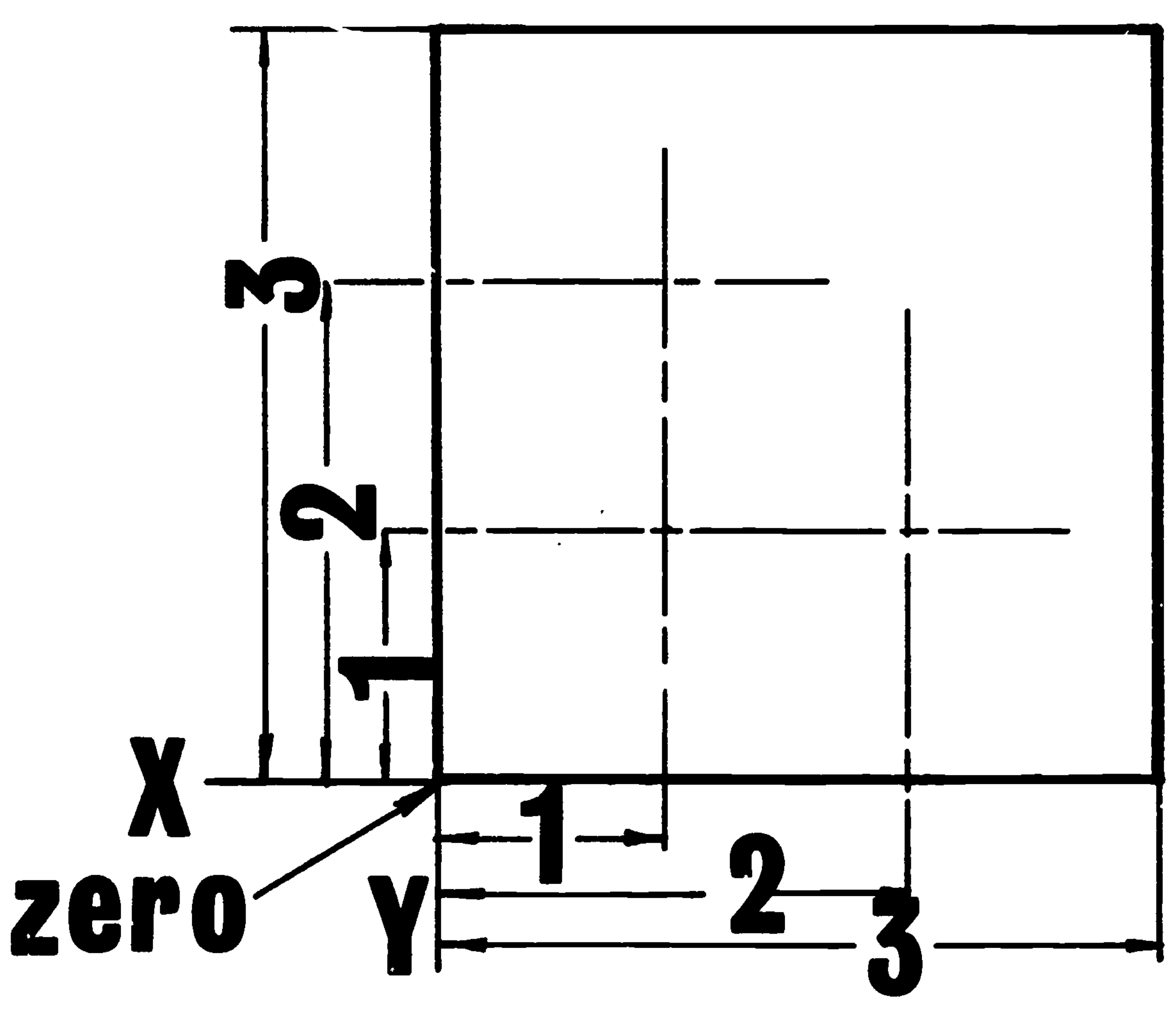
Coordinates of N.C. Machines



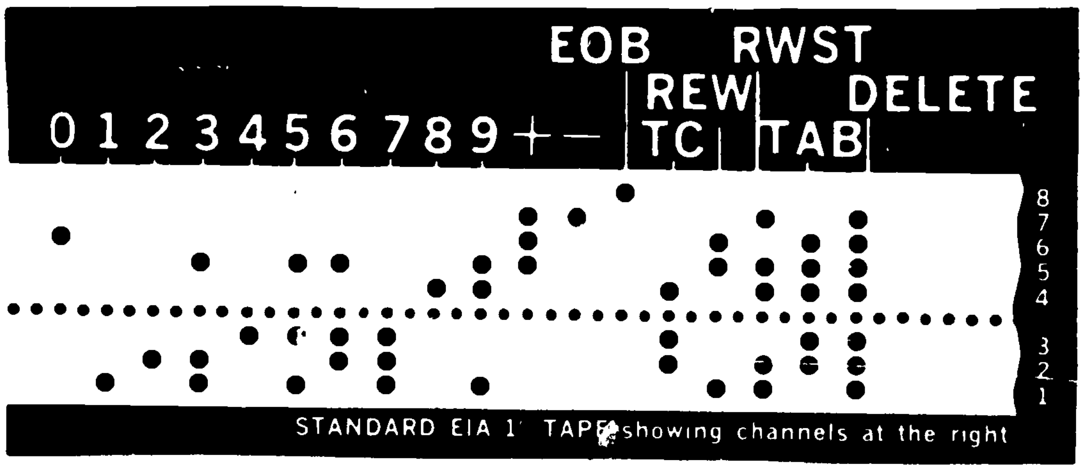
Conventional Drawing

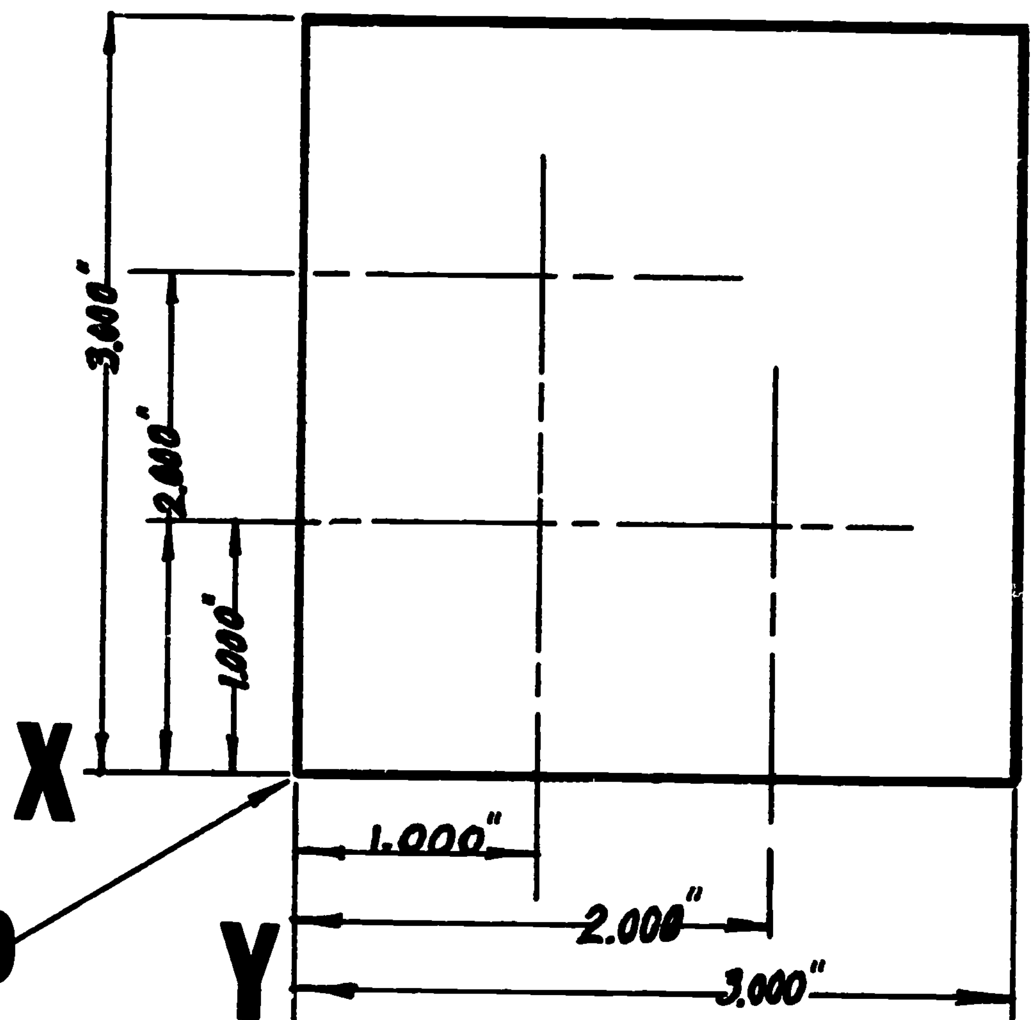


N.C. Dimensioning



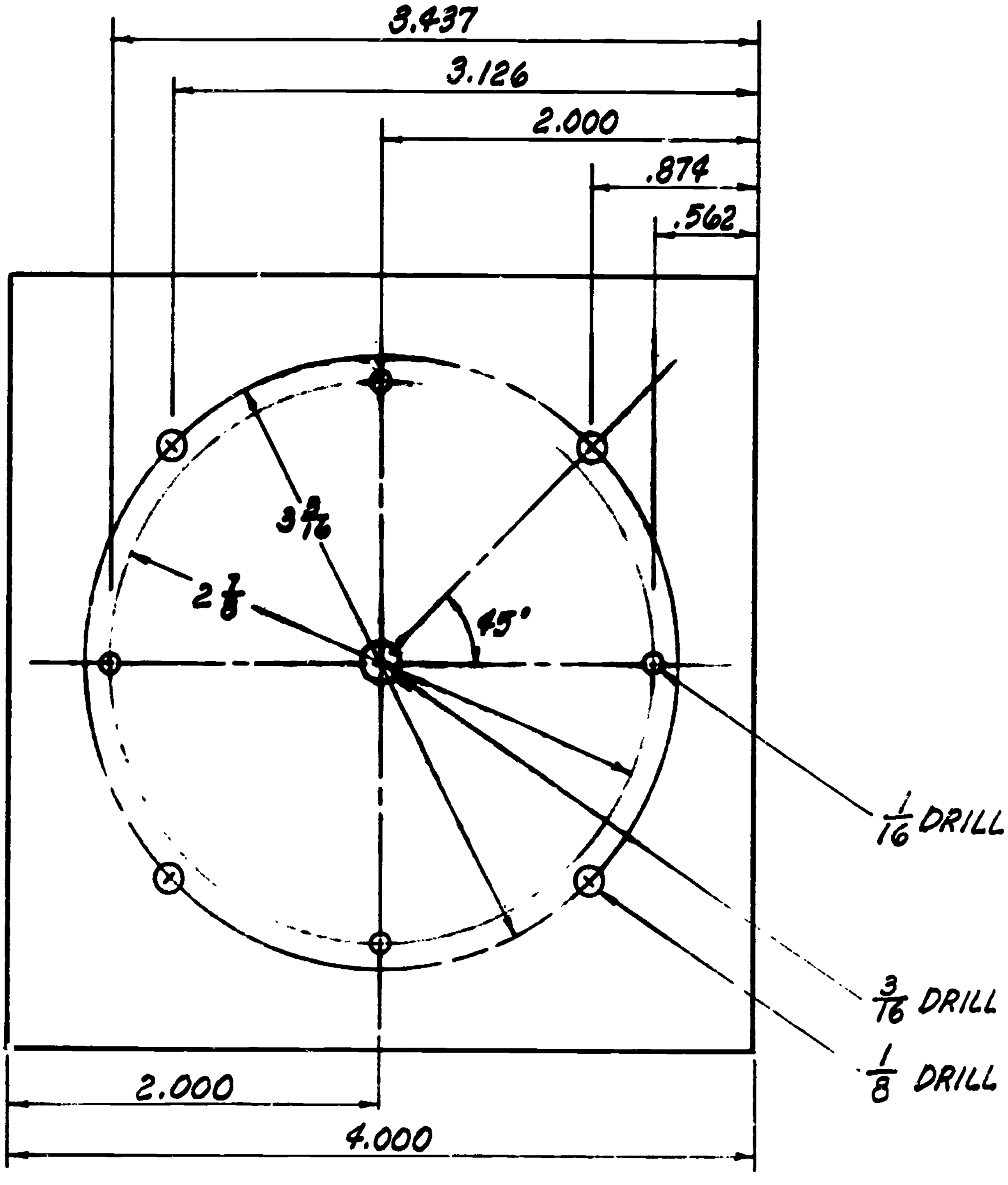
N.C. Code





Process sheet

SEQ. NO.	TAB OR EOB	+ OR −	"X" COORDINATE	TAB OR EOB	+ OR −	"Y" COORDINATE	TAB OR EOB	INSTRUCTIONS	EOB
000	T		0	T		0	E	Set up Zero from lower left corner	
001	T	+	1.000	T	+	2.000	E	Bore hole #1	



B.L.C.

AUTOSPOT SKETCH

MIAMI-DADE JUNIOR COLLEGE

AUTOSPOT II PRELIST


```
1 REMARK/FLANGE PLATE       $ MIAMI-DADE JUNIOR COLLEGE 1967 SUMMER INSTITUTE
2 REMARK/TP(4.575,-5.077)   $ MAXIMUM TABLE POSITION REFERRED TO SET UP POINT
3 DASH A    (0.575,-1.077)  $ DATUM SURFACE OR HOLE (REFERENCE SYSTEM) ID - A
4 START                     $ GENERATES A SEQUENCE NO. AND A REWIND STOP CODE
5 DRILL,0625/DAA,AT(2.0,-2.0)R(1.4375)SA(00.0)IA(90.0)NH(4)/DP(0.5)FR(5.0)$
6 DRILL,1250/DAA,AT(2.0,-2.0)R(1.5938)SA(45.0)IA(90.0)NH(4)/DP(0.5)FR(5.0)$
7 DRILL,1875/DAA    (2.0,-2.0)                                /DP(0.5)FR(5.0)$
8 FINI                      $ GENERATES A TOOL CHANGE AND AN AUTO REWIND CODE
```

```
END PREPROCESSOR
SPECIFICATION SECTION

MACHINE SECTION
END PHASE 1
PHASE2 SECTION

END PHASE2

AUTOSPOT-TAPE-O-MATIC POST PROCESSOR

PART NUMBER-       ,NAME
FLANGE PLATE       $ MIAMI-DADE JUNIO
TP(4.575,-5.077) $ MAXIMUM TABLE PO
001Ж-00575Ж+01077                          SET POINT          0001
$002     START                                                0002
         FEED RATE 05.0 IN/MIN
          DRILL CHANGE TOOL,TOOL NO. 0625
004Ж+03437Ж-02000                          DEPTH 0.5000       0004
005Ж+02000Ж-00562                                             0005
006Ж+00562Ж-02000                                             0006
007Ж+02000Ж-03437                                             0007
         FEED RATE 05.0 IN/MIN
Ж008      DRILL CHANGE TOOL,TOOL NO. 1250
009Ж+03126Ж-00873                          DEPTH 0.5000       0009
010Ж+00873Ж-00873                                             0010
011Ж+00873Ж-03126                                             0011
012Ж+03126Ж-03126                                             0012
         FEED RATE 05.0 IN/MIN
Ж013      DRILL CHANGE TOOL,TOOL NO. 1875
014Ж+02000Ж-02000                          DEPTH 0.5000       0014
Ж/015    STOP                                                 0015
FINI POST PROCESSOR

 TOTAL PRODUCTION TIME 001.2
```

001Ж0̄00575Ж0̄01077‡

=002‡

004Ж0̄03437Ж0̄02000‡

005Ж0̄02000Ж0̄00562‡

006Ж0̄00562Ж0̄02000‡

007Ж0̄02000Ж0̄03437‡

Ж008‡

009Ж0̄03126Ж0̄00873‡

010Ж0̄00873Ж0̄00873‡

011Ж0̄00873Ж0̄03126‡

012Ж0̄03126Ж0̄03126‡

Ж013‡

014Ж0̄02000Ж0̄02000‡

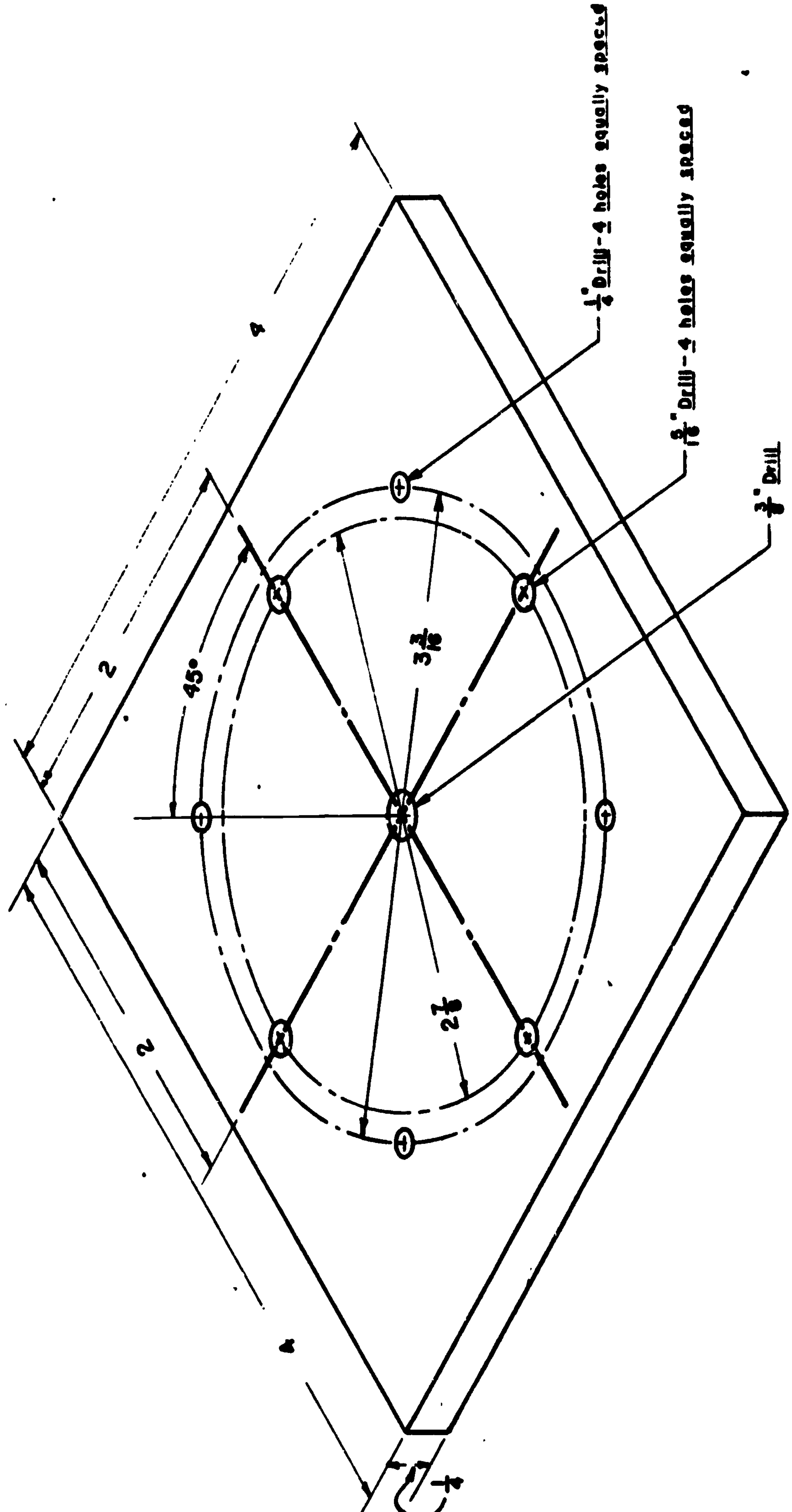
Ж1015‡

TAPE OUTPUT FROM AUTOSPOT II ACCORDING TO 1620 CHARACTERS

001	-00575	&01077
%002		
004	&03437	-02000
005	&02000	-00562
006	&00562	-02000
007	&02000	-03437
008		
009	&03126	-00873
010	&00873	-00873
011	&00873	-03126
012	&03126	-03126
013		
014	&02000	-02000
/015		

FRIDEN FLEXOWRITER INTERPRETATION OF TAPE OUTPUT FROM AUTOSPOT II OUTPUT

MDJCTVS: '67
JPC:



THE PROGRAM OR PROCESS SHEET

MDJCT013004
MDP - JPC

PROGRAMMING FOR P & W TAPE O-MATIC

DWG. NO. 301	OPER NO	PART NAME	PREPARED BY DATE 2/18/64 JPC
PART NO. A-56	324	STUDENT PROJECT	CH'ED BY DATE 2/24/64 JPC
			SHEET 1 OF 1

LATEST DWG. CHGE	REMARKS	
2/12/64	CUT TAPE ON FLEXOWRITER NC-1	DEPT. NO. 6
		TAPE NO. 1

MISC. FUNC.	SEQ. NO.	TAB OR EOB	+ OR -	"X" COORDINATE	TAB OR EOB	+ OR -	"Y" COORDINATE	TAB OR EOB	INSTRUCTIONS	EOB
		T	-	.575	T		1.081	EOB	Set up from upper left corner of fixture. Zero point at upper left corner of plate.	
RWST	001	T		.874	T	-	.874	EOB	center drill 9 holes	
	002	T		2.000	T	-	.562	EOB		
	003	T		3.126	T	-	.874	EOB		
	004	T		3.437	T	-	2.000	EOB		
	005	T		2.000	EOB					
	006	T		.562	EOB					
	007	T		.874	T	-	3.126	EOB		
	008	T		2.000	T	-	3.437	EOB		
	009	T		3.126	T	-	3.126	EOB		
TC	010	T		6.000	T	-	4.000	EOB	1/4" DRILL 4 holes thru	
	011	T		2.000	T	-	3.437	EOB		
	012	T		3.437	T	-	2.000	EOB		
	013	T		.562	EOB					
	014	T		2.000	T	-	.562	EOB		
TC	015	T		6.000	T	-	4.000	EOB	5/16" DRILL 4 holes thru	
	016	T		.874	T	-	.874	EOB		
	017	T		3.126	EOB					
	018	T			T	-	3.126	EOB		
	019	T		.874	T			EOB		
TC	020	T		6.000	T	-	4.000	EOB	3/8" DRILL 1 hole thru	
	021	T		2.000	T	-	2.000	EOB		
TC RW	022	T		6.000	T	-	4.000	EOB		

PW-4219

C O M P U D Y N E   N. C.   M I L L

	EOR *	Rewind Stop
	G00 *	Position Mode
	-Z0150 *	
	G60F46 *	Feed Mode
	-X-Y0875 *	
No 1	-Y1875 *	
No 2	G01(3/4 R, 90°) *	Inscremental Mode
No 3	G60 -X0586 *	Feed Mode
No 4	G01(¼ R, tan 45°) *	Incremental Mode
No 5	G60 -X-Y0707 *	Feed Mode
No 6	G01 (3/4R, 135°) *	Incremental Mode
No 7	G60 +Y2000 *	Feed Mode
No 8	G01 (3/4R, 90°) *	Incremental Mode
No 9	G60 +X2875 *	Feed Mode
	+Z0150 *	
	G00-X-Y 1875 *	Position Mode
No 10	G60-Z0087 *	Feed Mode
	-X0500 *	
	G01 (Angle) *	Incremental Mode
	G60-Y1000 *	Feed Mode
	-X+Y0250 *	
	+X+Y0125 *	
	+Z0087 *	
	G00 *	Position Mode
	-X+Y0500 *	
No 11	G60 -Z0150	Feed Mode
	-X-Y0125 *	
	-X+Y0250 *	
	-Y1000 *	
	G01 (Angle)	Incremental Mode
	G60-X0500 *	Feed Mode
	+Z0150 *	
	G00-Y2000 *	Position Mode
No 12	G60 +Y0031 *	Feed Mode
	-Z0300 *	
	G01 (5/3z R, 360°)	Incremental Mode
	+Z0300 *	
	G00+X+Y1000 *	Position Mode
	+X1000 *	
No 13	-Z0150 *	
	G01 (5/3z R, 360°) *	Incremental Mode
	+Z0150 *	
	G00 *	Position Mode
	-Y0031 *	
	+X+Y1750 *	
	+Y1000 *	
	M02 *	Program stop, Rewind

NUMERICALLY CONTROLLED

PRATT-WHITNEY

DRILLING MACHINE

I. Machine Characteristics

A. Speed of table
   1. HIGH SPEED - 300" per minute to .256" of command position
   2. MEDIUM SPEED - 8" per minute to .004" of command position
   3. LOW SPEED - .5" per minute to command position

B. Spindle speed
   1. LO SPEED - 150 to 1000 R.P.M.
   2. HI SPEED - 300 to 2000 R.P.M.

II. Dimensioning system

A. ZERO point is the center of the cartesion coordinate system.

B. The ZERO point is chosen by the programmer for convenience or achieve the minimum operational time sequence.

C. All dimensions are on a corrdinate system located from the ZERO point which is the intersection of the X and Y coordinates.

III. Control panel

A. The MAIN DISCONNECT SWITCH on the front of the control cabinet turns all power off and on.

B. The START BUTTON on the machine control panel, starts all electrical apparatus is the control cabinet.

C. The MODE SWITCH on the machine control panel:
   1. In the OFF position cuts out all machine respone to tape signals.
   2. In MANUAL position allows single positioning of the table on tape commands.
   3. In the AUTO position allows for automatic positioning sequencing of the table on tape command.

D. The TAPE ADVANCE button feeds in the next block of information from the tape.

E. The JOG SPEED switch labeled HIGH, MEDIUM, and LOW refers to the table positioning speeds 300", 8", and 0.5" per minute.

F. The JOG switches for TABLE and CARRIAGE, labeled IN, OUT, and LEFT, RIGHT work in conjunction with the SPEED KNOB and are used for the initial setting of the work piece.

G. A REPOSITIONING BUTTON is used when the job has to be moved away from under the spindle (Measurements, inspection, etc.) the JOG SWITCHES move the table and carriage to the new position. When the measurements and inspection etc. are completed, the RESPOSITIONING BUTTON is pressed bringing the table and spindle back to their original relationship.

H. A STOP TAPE REWIND button will stop the passage of a long tape at any point in the rewind cycle (Pick up a skipped hole).

I. The two ZERO BUTTONS control the corrdinate position of the X and Y axis, the X axis being the table, the Y axis being the carriage and the intersection of X and Y being the ZERO point. They may be pressed independently or simultaneously.

J. Signal lights:
   1. The light labeled SET MACHINE means the zero should be established.
   2. The light labeled READY means the machine is ready to receive the next block of information from the tape.
   3. The light labeled TOOL CHANGE means the table has moved to a prearranged position on tape signal and a tool change is in order.

K. The switch labeled SPINDLE SPEED OFF, HI, LO, controls the continuously variable spindle speed.

L. At the top or retracted position of the drill spindle, a stop will actuate a micro-switch activating the tape advance and feeding in the next block of information automatically. The table will move in response to the tape command.

NOTE:

1. For safety purposes the automatic tape controlled spindle feed has been omitted and all spindle movement is manually controlled.

2. When the main disconnect switch is turned to OFF position, all information in the memory bank is cancelled out. When the main disconnect switch is turned to the ON position, the coordinates of the spindle center line then become the new starting ZERO.

JPC/bmj

M I A M I - D A D E   J U N I O R   C O L L E G E

11380 NORTHWEST 27 AVENUE

MIAMI, FLORIDA 33167

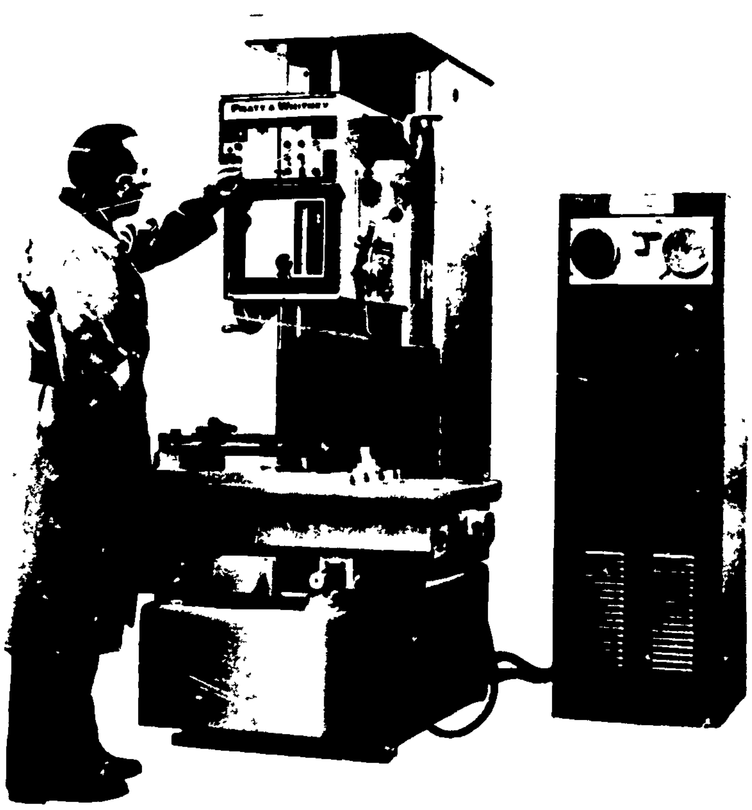
MANUAL PROGRAMMING
FOR
PRATT & WHITNEY
TAPE-O-MATIC DRILL

FOR EDP 222 - COMPUTER TECHNOLOGY APPLICATION

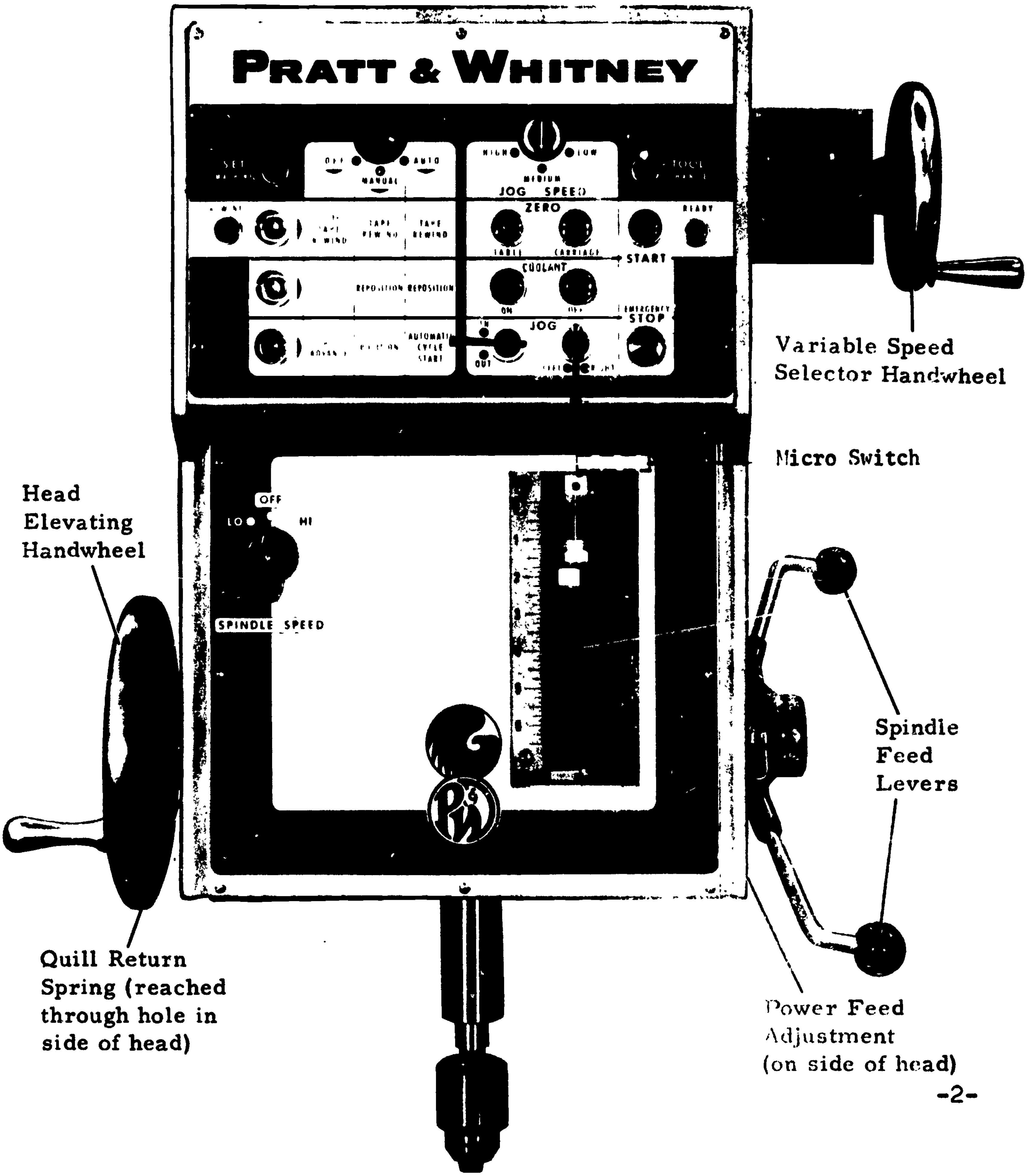
DEPARTMENT OF INSTRUMENTATION & AUTOMATION

The Division of
Technical, Vocational, and Semiprofessional Studies

TABLE OF CONTENTS



CONTROL PANEL, TAPE-O-MATIC DRILL



NUMERICALLY CONTROLLED

PRATT-WHITNEY

TAPE-O-MATIC

DRILLING MACHINE

I. MACHINE CHARACTERISTICS

A. Speed of table
1. HIGH SPEED - 300" per minute to .256" of command position.
2. MEDIUM SPEED - 8" per minute to .004" of command position.
3. LOW SPEED - .5" per minute to command position.

B. Spindle speed
1. LO SPEED - 150 to 1000 R.P.M.
2. HI SPEED - 300 to 2000 R.P.M.

II. DIMENSIONING SYSTEM

A. ZERO point is the center of the cartesian coordinate system.
B. The ZERO point is chosen by the programmer for convenience or to achieve the minimum operational time sequence.
C. All dimensions are on a coordinate system located from the ZERO point which is the intersection of the X and Y coordinates.
D. All four quadrants of the coordinate system can be used simultaneously.

III. CONTROL PANEL

A. The MAIN DISCONNECT SWITCH on the front of the control cabinet, turns all power off and on.
B. The START BUTTON on the machine control panel, starts all electrical apparatus in the control cabinet.
C. The MODE SWITCH on the machine control panel:
1. In the OFF position cuts out all machine response to tape signals.
2. In MANUAL position allows single positioning of the table on tape commands.
3. In the AUTO position allows for automatic positioning and sequencing of the table on tape command.

D. The TAPE ADVANCE button feeds in the next block of information from the tape.
E. The JOG SPEED switch labeled HIGH, MEDIUM, and LOW refers to the table positioning speeds of 300", 8", and 0.5" per min.
F. The JOG switches for TABLE and CARRIAGE, labeled IN, OUT, and LEFT, RIGHT work in conjunction with the JOG SPEED KNOB and are used for the initial setting of the work piece.

G. A REPOSITIONING BUTTON is used when the job has to be moved away from under the spindle (Measurements, inspection, etc). The JOG SWITCHES move the table and carriage to the new position. When the measurements and inspection etc. are completed, the REPOSITIONING BUTTON is pressed bringing the table and spindle back to their original relationship.

H. A STOP TAPE REWIND button will stop the passage of a long tape at any point in the rewind cycle (Pick up a skipped hole).

I. The two ZERO BUTTONS control the coordinate position of the X and Y axis, the X axis being the table, the Y axis being the carriage and the intersection of X and Y being the ZERO point. They may be pressed independently or separately.

J. Signal lights:
   1. The light labeled SET MACHINE means the zero should be established.
   2. The light labeled READY means the machine is ready to receive the next block of information from the tape.
   3. The light labeled TOOL CHANGE means the table has moved to a pre-arranged position on tape signal and a tool change is in order.

K. The switch labeled SPINDLE SPEED, OFF, HI, LO, controls the continuously variable spindle speed.

L. At the top retracted position of the drill spindle a stop will actuate a micro-switch activating the tape advance and feeding in the next block of information automatically. The table will move in response to the tape command.

NOTE:

1. For safety purposes the automatic tape controlled spindle feed has been omitted and all spindle movement is manually controlled.

2. When the main disconnect switch is turned to OFF position, all information in the memory bank is cancelled out. When the main disconnect switch is turned to the ON position, the coordinates of the spindle center line then become the new starting ZERO.

SEQUENTIAL STEPS

FOR

OPERATING THE P. W. TAPE-O-MATIC

1. Turn DISCONNECT SWITCH to ON position. Disconnect Switch is located on right front door of control cabinet.

2. Turn MODE SWITCH to OFF position. Mode Switch is located on top left side of Tape-O-Matic Machine control panel.

3. Push START BUTTON.

4. Put the tape in the machine with the printed side up engaging the sprocket pins with the small feed holes. Keep the shortest distance from the edge of the tape to the sprocket holes towards the operator. The tape will feed from RIGHT to LEFT and must be started on the lead or on command portion of the tape.

5. Push TAPE ADVANCE BUTTON and feed in the first block of information.

6. Push both ZERO BUTTONS.

7. Turn MODE SWITCH to AUTO and insert first drill of program sequence in Jacobs Drill Chuck. (CAUTION)-Tighten drill chuck with chuck wrench and REMOVE chuck wrench.)

8. Push the TAPE ADVANCE BUTTON and feed in the next block of information. The table will immediately move to the command position.

9. Turn the SPINDLE SPEED control to desired speed.

10. Perform sequence of operations. (CAUTION)-When the spindle retracts it will activate a MICRO SWITCH causing the tape to feed in each successive block of information AUTOMATICALLY with the table responding immediately to the command signal. This will stop when the TOOL CHANGE signal is received by the machine.

11. Change drill to next size required.

12. Push the TAPE ADVANCE BUTTON and feed in the next block of information.

13. Perform subsequent operations sequencing automatically to TOOL CHANGE.

14. Repeat 11, 12, and 13 until all operations are completed.

15. Upon reaching the command REW-TC tape will rewind and table will move to tool-change position.

16. Remove drilled plate from machine and clean table and/or fixture.

CODE INSTRUCTIONS

FOR

PROGRAMMING THE PW TAPE-O-MATIC

I SYMBOLS

(A) Numerical 0 to 9

(B) Delete: Erasures

(C) EOB: End of Block meaning read and act on all previous information.

(D) TAB: Read and remember this information

(E)-: MINUS precedes all dimensions taken in the minus direction from the Zero point.

(F)+: PLUS precedes all dimensions taken in the positive direction from the Zero point when required by the tape coding device. (All numbers not preceded by a minus sign are recognized by the machine as positive dimensions when coded on the Friden Flexowriter.

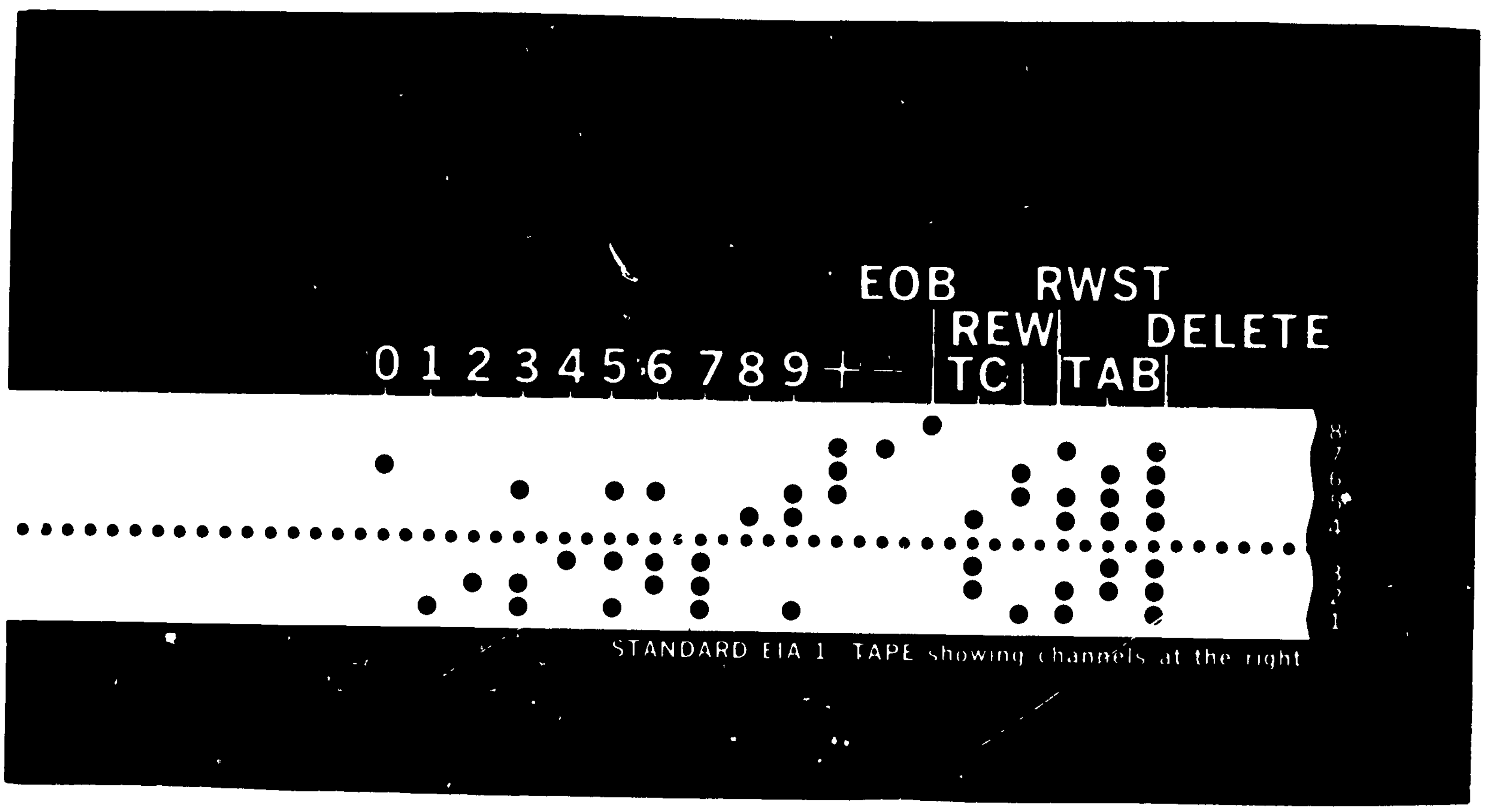
(G) RW: Rewind meaning to rewind tape back to the starting point.

(H) RWST: Rewind stop meaning to stop the rewinding tape at that command.

(I) TC: Tool Change meaning to move the table to a predetermined position so the tool may be changed.

TAPE SPECIFICATIONS AND DEFINITIONS

TAPE SPECIFICATIONS: The TAPE-O-MATIC operates using the standard EIA 1" wide, 8 channel, 1-2-4-8 code tape. A section of the tape is shown. Definitions are given below.



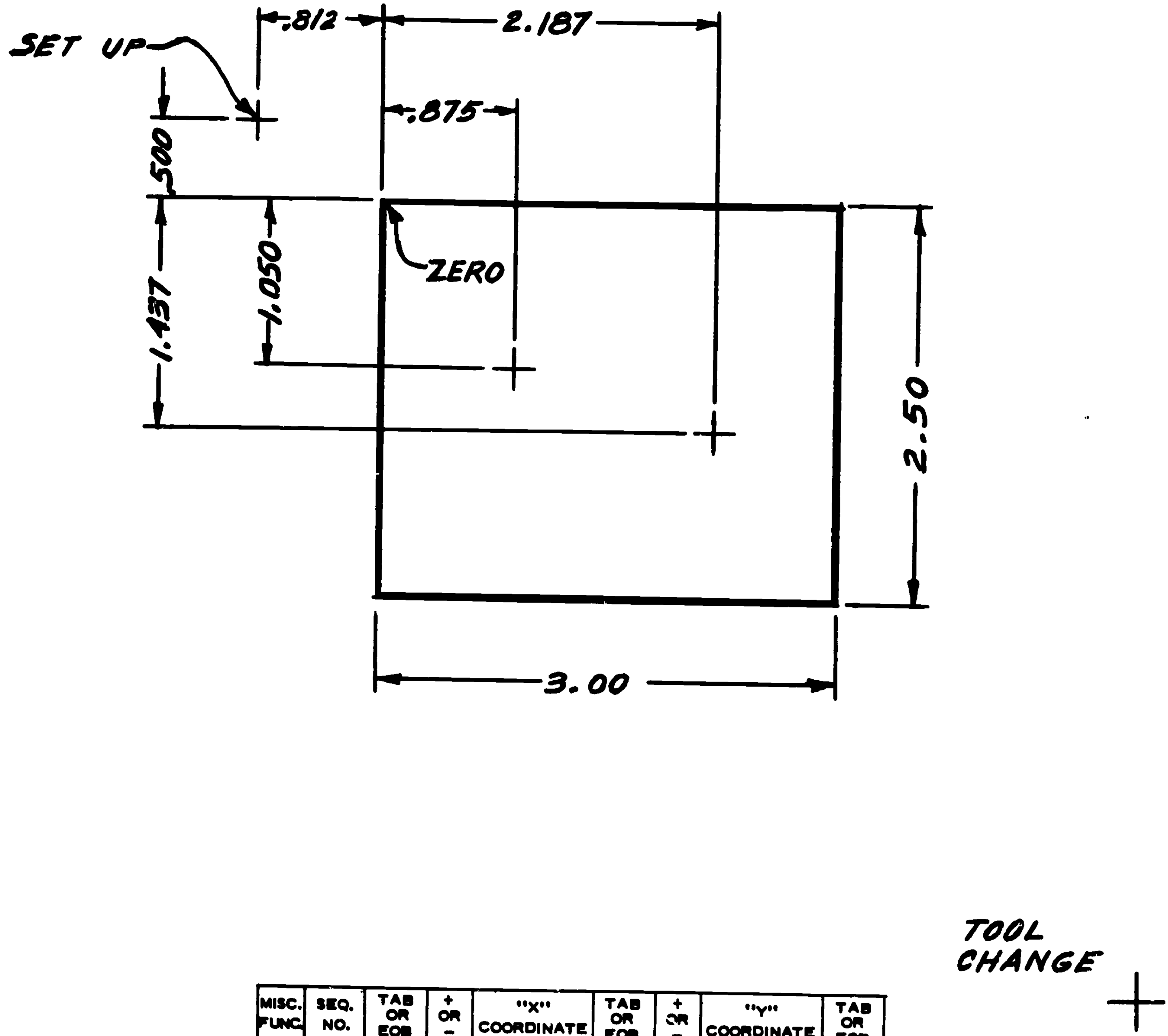
STANDARD EIA 1" TAPE showing channels at the right

TAPE DEFINITIONS:

1. **Track:** a path parallel to the edge of the tape along which information may be stored by means of the presence or absence of holes.

2. **Row.** Any path perpendicular to the edge of the tape.

3. **Character:** Each row of holes made up of a particular combination of holes in the eight tracks represent one character. The meaning of the character depends on the number and position of the holes.



MISC. FUNC.	SEQ. NO.	TAB OR EOB	+ OR −	"X" COORDINATE	TAB OR EOB	+ OR −	"Y" COORDINATE	TAB OR EOB
	000	T		.812	T	−	.500	EOB
RW ST	001	T		.875	T	−	1.050	EOB
TC	002	T		5.000	T	−	5.000	EOB
	003	T		2.187	T	−	1.437	EOB
REW								
TC	001	T		5.000	T		5.000	EOB

SAMPLE PROGRAM

SEQUENTIAL STEPS

FOR

SAMPLE PROGRAM

1. SEQUENCE 000
   (a) T, TAB meaning read and remember the next block of information, but do not act.

   (b) -, MINUS taken from the zero coordinate intersection.

   (c) .812, Meaning the X coordinate to the center of the zero point. The number is understood to be positive when the sign is omitted. Preceding zeros to the left of the decimal point are omitted, as the machine would ignore them. The machine always reads to three decimal places which automatically positions the decimal point. (NOTE-The zeros to the right of the decimal point are significant digits.)

   (d) T, TAB meaning read and remember the next block of information.

   (e) .500, meaning the Y coordinate to the center of the zero point.

   (f) EOB, End of Block. This normally means read and act on command except for the setting up of the zero point. This information will be held by pressing the zero buttons.

2. SEQUENCE 001
   (a) RWST, Rewind Stop means stop the tape at this point when rewinding.

   (b) T, TAB meaning read and remember.

   (c) .875, meaning X coordinate to first hole.

   (d) T, TAB meaning read and remember.

   (f) 1.050, meaning Y coordinate to first hole.

(g) EOB, End of Block meaning read and act on all previous information.

(h) Drill hole.

3. SEQUENCE 002
   (a) TC, Tool Change meaning go to command position.

   (b) T, TAB meaning read and remember.

   (c) 5.000 means X coordinate of TC position.

   (d) T, TAB meaning read and remember.

   (e) -, MINUS from zero point.

   (f) 5.000 means Y coordinate of TC position.

   (g) EOB, End of Block, read and act on previous information.

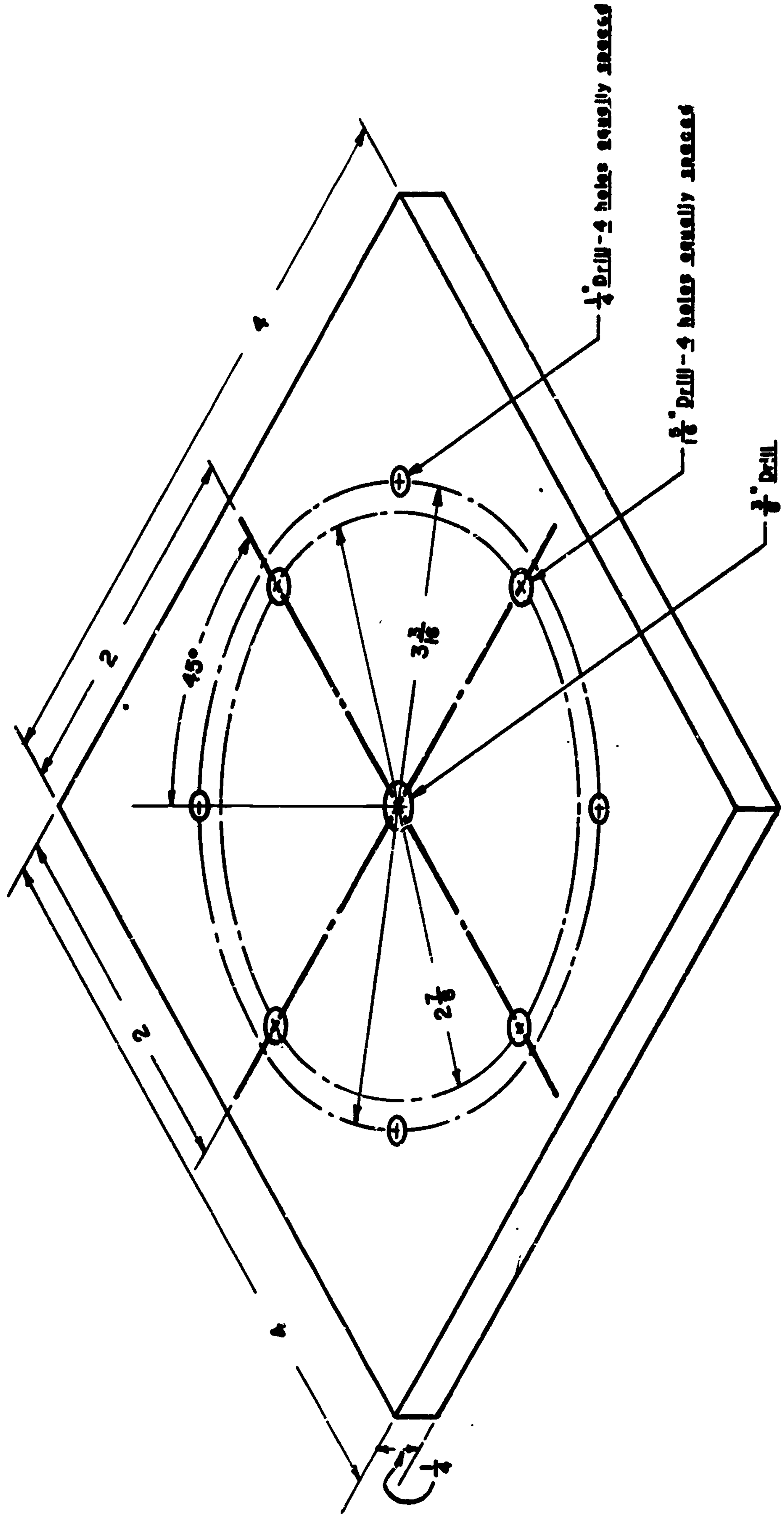
   (h) Change Drills.

4. SEQUENCE 003
   (a) Drill hole at coordinate position x 2.187 and Y 1.437.

5. SEQUENCE 004
   (a) RW, Rewind means rewind during movement to next command position which is TC or Tool Change at X 5.000 and Y 5.000

NOTE- The sequence numbers do not have to be in numerical order and although coded in on the tape, they have no effect on the operation of the machine. They are used to activate a direct reading sequential dial when such a dial is installed on the machine.

MDJCTS-030984
EG-102-MHN



On a drawing sheet 8 1/2" X 11" make a two view drawing of the PLATE. Dimension completely, using the conventional form of dimensioning.

On a drawing sheet 8 1/2" X 11" make a two view drawing of the PLATE. Dimension it in MR ERIC form. The "zero point", normally located by the process planner, you are to locate at the upper left corner of the piece. The "set-up" point will be located later. All dimensions are to be to 3 decimal places. Scale: - Full size.

ENGINEERING GRAPHICS 102 MIAMI-DADE JUNIOR COLLEGE	Name Code Date	C-0100

THE PROGRAM OR PROCESS SHEET

MDJC 6013064
MDP - JPC

PROGRAMMING FOR P&W TAPE-O-MATIC

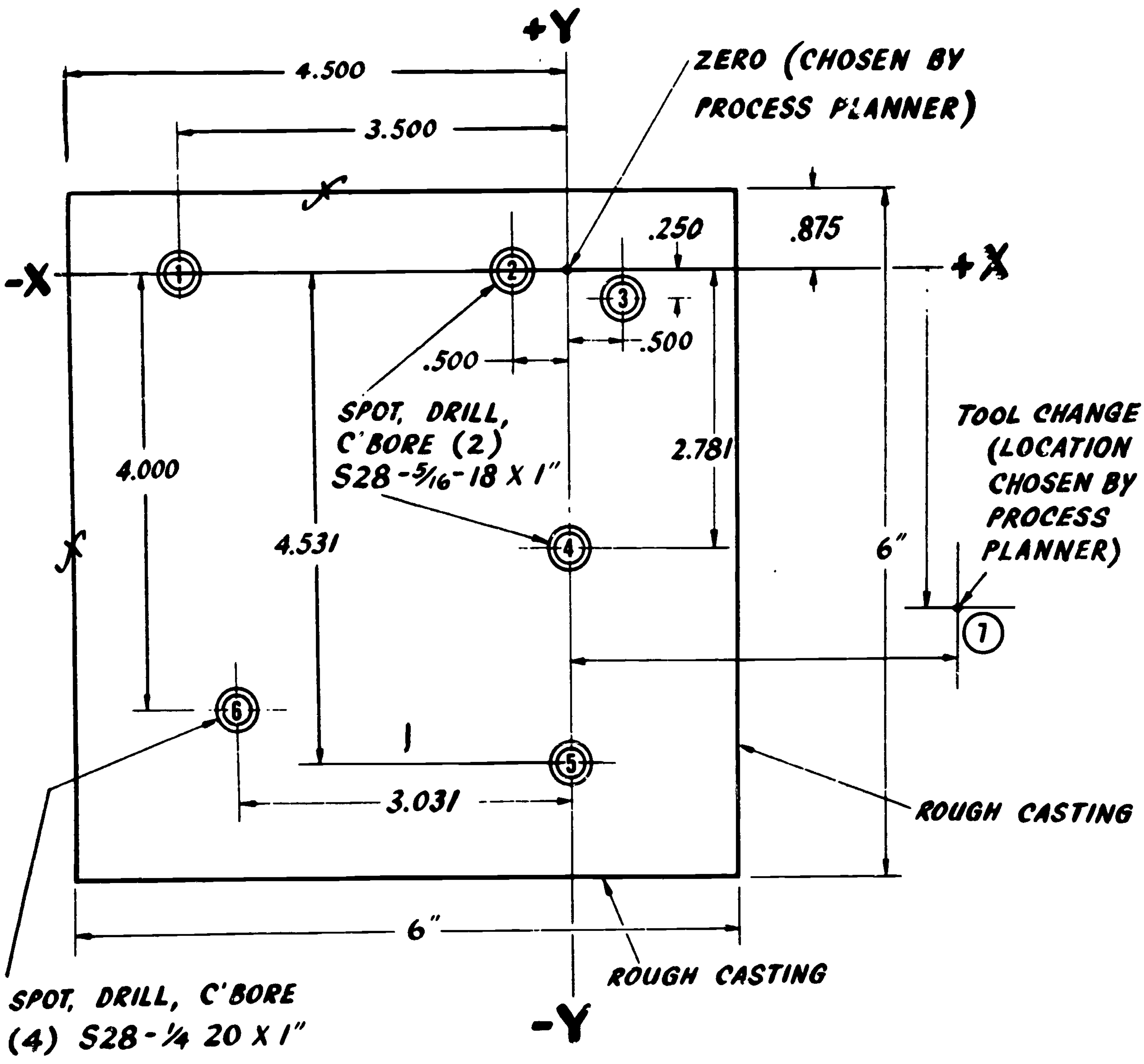
DWG NO 301	ORDER NO 324	STUDENT PROJECT	PREPARED BY DATE 2/18/64 JPC
PART NO A-56			CH'ED BY DATE 2/24/64 JPC
LATEST DWG. CHGE 2/12/64	REMARKS CUT TAPE ON FLEXOWRITER NC-1		SHEET 1 OF 1
			DEPT NO 6
			TAPE NO 1

MISC. FUNC	SEQ. NO.	TAB OR EOB	+ OR -	X COORDINATE	TAB OR EOB	+ OR -	Y COORDINATE	TAB OR EOB	INSTRUCTIONS	EOB
		T	-	.575	T		1.081	EOB	Set up from upper left corner of fixture. Zero point at upper left corner of plate.	
RWST	001	T		.874	T	-	.874	EOB	centerdrill 9 holes	
	002	T		2.000	T	-	.562	EOB		
	003	T		3.126	T	-	.874	EOB		
	004	T		3.437	T	-	2.000	EOB		
	005	T		2.000	EOB					
	006	T		.562	EOB					
	007	T		.874	T	-	3.126	EOB		
	008	T		2.000	T	-	3.437	EOB		
	009	T		3.126	T	-	3.126	EOB		
TC	010	T		6.000	T	-	4.000	EOB	1/4" DRILL 4 holes thru	
	011	T		2.000	T	-	3.437	EOB		
	012	T		3.437	T	-	2.000	EOB		
	013	T		.562	EOB					
	014	T		2.000	T	-	.562	EOB		
TC	015	T		6.000	T	-	4.000	EOB	5/16" DRILL 4 holes thru	
	016	T		.874	T	-	.874	EOB		
	017	T		3.126	EOB					
	018	T			T	-	3.126	EOB		
	019	T		.874	T			EOB		
TC	020	T		6.000	T	-	4.000	EOB	3/8" DRILL 1 hole thru	
	021	T		2.000	T	-	2.000	EOB		
TC RW	022	T		6.000	T	-	4.000	EOB		

PR-4213

ENGINEERING GRAPHICS 102 MIAMI-DADE JUNIOR COLLEGE	Name Code Date	C-0104

TYPICAL ENGINEERING DRAWING WITH NUMERIC DIMENSIONS



	Name Code Date	C-0101

MDJCTS013064
MDP - JPC

PROGRAMMING FOR P&W TAPE-O-MATIC

DWG. NO.	OPER. NO.	PART NAME	PREPARED BY
PART NO.			DATE
			CH'ED BY
			DATE
			SHEET OF

LATEST DWG, CHGE	REMARKS:	DEPT. NO.
		TAPE NO.

SC. INC.	SEQ. NO.	TAB OR EOB	+ OR –	"X" COORDINATE	TAB OR EOB	+ OR –	"Y" COORDINATE	TAB OR EOB	INSTRUCTIONS	EOB

MDJCTS013064
MDP - JPC

PROGRAMMING FOR P&W TAPE-O-MATIC

DWG. NO.

PART NO.

OPER. NO.

PART NAME

PREPARED BY
DATE
CH'ED BY
DATE
SHEET OF
DEPT. NO.
TAPE NO.

LATEST DWG, CHGE

REMARKS:

ISC. UNC.	SEQ. NO.	TAB OR EOB	+ OR −	"X" COORDINATE	TAB OR EOB	+ OR −	"Y" COORDINATE	TAB OR EOB	INSTRUCTIONS	EOB

MIAMI-DADE JUNIOR COLLEGE

11380 NORTHWEST 27TH AVENUE

MIAMI, FLORIDA 33167

AUTOSPOT II
FOR THE PRATT & WHITNEY
TAPE-O-MATIC NUMERIC DRILLING MACHINE

FOR EDP 222 – COMPUTER TECHNOLOGY APPLICATIONS

DEPARTMENT OF INSTRUMENTATION AND AUTOMATION

THE DIVISION OF
TECHNICAL, VOCATIONAL, AND SEMIPROFESSIONAL STUDIES

PREFACE

The AUTOSPOT Program is an outgrowth of a situation encountered at IBM's Space Guidance Center where numerically controlled point-to-point machine tools are utilized to produce repeated short-run parts. The programming effort required to manually prepare these instructions demanded that an improved method be developed and employed. The study that followed resulted in the AUTOSPOT Program.

The Miami-Dade Junior College AUTOSPOT II System is composed of three separate computer programs: an AUTOSPOT II Preprocessor Program written by D. F. McManigal of IBM, AUTOSPOT II Compiler written by IBM, and the AUTOSPOT II Post Processor Program for the Pratt and Whitney Tape-O-Matic Numeric Drilling Machine written by W. R. Paul, A. J. Tomarchio, and W. J. Cartmell of IBM.

The preprocessor checks the AUTOSPOT II source statements for errors, and if a statement is in error, the preprocessor types out the statement in error, and the portion of the statement in error with a self-explanatory error message.

AUTOSPOT II makes the calculations necessary for the Pratt & Whitney Drill to be positioned correctly over the parts to be drilled.

The post processor then converts the calculations of AUTOSPOT II into a punched paper tape which contains the calculations of AUTOSPOT II in a form that the Pratt & Whitney Drill can understand and act upon in the prescribed manner.

These three programs were originally designed to use the Card Reader-Punch and typewriter for input and output. Where appropriate, the programs were converted to use the Disk for input and output and the printer for output.

As the result of these changes, the time required to run an average size AUTOSPOT II Program was reduced from twenty-five minutes to two minutes for an error-free program.

Many of the facilities of the three programs were deleted, either because they were not needed or used by the Pratt & Whitney Drill, or because they were too time-consuming for use in a class laboratory, i.e., typewriter input. For the complete write-up on these three programs, you are referred to these IBM publications:

1. AUTOSPOT II Preprocessor Program -- IBM File No. 10.4.009

2. AUTOSPOT II -- IBM File No. 1620-GN-05X

3. AUTOSPOT II Post Processor Program for the Pratt & Whitney Tape-O-Matic Numeric Drilling Machine -- IBM File No. 10.4.005.

Table of Contents

OPERATING INSTRUCTIONS

Program	Switches
#1	ON -- printer listing of source statements
	OFF -- no listing
#2	ON -- typewriter listing of paper tape output from post-processor
	OFF -- no listing
#3 and #4	not used

All other switches _must_ be set to program.

Notes:

If an error occurs in any of the sections, the preprocessor will be recalled from disk at the end of the section.

Please run with Switch #2 OFF unless there is an urgent need for a listing of the paper tape. If Switch #2 is ON, the typewriter tabs must be set at 40, 60, and 80.

If the computer stops while punching tape with the automatic and manual lights on, push the start button to continued processing unless the write check indicator is on; if it is on, the program must be rerun because the tape has been incorrectly punched.

Upon the successful completion of the post-processor section, the computer halts -- push start to recall the preprocessor and process the next program.

A plus or minus sign _cannot_ precede a decimal point. Example:

WRONG -- .575

RIGHT -- 0.575

AUTOSPOT input may be stacked if done in the following manner:

AUTOSPOT cold start card

Source Program Number 1

Source Program Number 2

. . . .

. . . .

Source Program Number N

Tool cards must be used in conjunction with the SPDRL and CSK commands in the machine section of AUTOSPOT programs. All other commands do not require tool cards.

If feed rate information, i.e., FR(XX.X), is left out of the auxiliary section of a machine statement, the post-processor will attempt to divide by zero and the following error message will result:

$\bar{1}358400\bar{0}7$

To resume processing, perform the following procedures:

1. press RESET
2. press INSERT
3. type on the typewriter - 4913584
4. press RELEASE
5. press START

Pratt & Whitney Setup Operating Procedure

A. Turn power ON and place the tape in the Reader.

B. Turn mode switch to manual.

C. Use the jog switches to center the quill over the machine setup point.

D. Turn the mode switch to OFF.

E. Push the tape advance button to read in the first block of information -- the first block of information on the tape must contain the coordinates of the machine setup point FROM the part zero point.

F. Depress the two zero buttons -- this zeros the machine at the part zero point.

G. Turn the mode switch to manual or automatic.

H. Commence operation.

ERROR MESSAGES

The AUTOSPOT system consists of five sections. The preprocessor has one section, the compiler has three sections, and the post-processor has one section. Each section has its own particular error messages.

1. Preprocessor Section

The standard error message consists of five fields. The first field contains the action code:

E	Capacity Exceeded
C	Language Error

The second field contains the error category:

NO	Input data missing
FORM	Form error (i.e., wrong punctuation or missing DATA entry)
COUNT	Entry count exceeds limit
UNDEF	Required reference is undefined
MULDEF	Reference is multiply defined (i.e., two DASHA statements)
CHECK	Possible logical error
PAT	Pattern usage error
MILL	Milling operation error

The third field contains the error description, as defined in the error message list.

The fourth field contains the data field being checked. This field may be blank, indicating missing data or erroneous punctuation.

The fifth field contains the punctuation following the data field in question. This field may be blank, a line without an asterisk, or a dollar sign.

Error messages are as follows:

E	COUNT DASH	More than 10 DASHes specified; this DASH will be undefined
E	COUNT DH	More than 3 deep hole sequences specified; this DH will be undefined
E	COUNT PAT	More than 20 patterns specified; this pattern will be undefined
C	FORM DEF	Format error in definition statement
C	FORM MAJOR	Format error in major section
C	FORM MINOR	Format error in minor section
C	FORM AUX	Format error in auxiliary section

ERROR MESSAGES -- (continued)

C	FORM REMARK		Format error in REMARK statement
C	UNDEF DASH		Undefined DASH
C	UNDEF OPER		Undefined operation code
C	UNDEF PAT		Undefined pattern
C	UNDEF DH		Undefined deep hole sequence
C	MULDEF PAT		Multiply defined pattern
C	COUNT POINT	(a)	In statement of form: DASHB=DASH(X,Y,Z)$ The number of X, Y, and Z entries does not match DASHB.
		(b)	Minor section has more than 25 X, Y, and Z entries.
		(c)	Pattern has more than 32 X, Y, and Z entries.
		(d)	Incorrect number of X, Y, and Z entries in coordinate set.
		(e)	NH greater than 32.
C	NO DIAM		TOOL/ statement (other than CSK or SPDRL) has no diameter entry
C	NO TIPANG		TOOL/ statement for CSK or SPDRL has no tip-angle entry
C	NO SETDIST		TOOL/ statement has no setting distance entry'
C	NO EFFLENG		TOOL/ statement for PILOTO has no effective length entry
C	UNDEF TOOL		Undefined tool; this message will not appear if no tools are defined
C	MULDEF TOOL		Multiply defined tool
E	COUNT TOOL		More than 50 tools specified; this tool will be undefined
C	COUNT DIAM		More than 6 diameters in DH sequence
C	COUNT THEN		More than 9 THEN connectors in a statement
C	PAT MANIP	(a)	REV used with second or third generation pattern.
		(b)	Pattern rotation without relocation.
		(c)	Rotation of rotated pattern.
		(d)	Inversion of inverted pattern.

ERROR MESSAGES -- (continued)

C	PAT LEVEL	(a) Pattern generation above third. (b) Sub-patterns of second or third generation pattern are not all of the next lower level. (c) GOTO, STOP, or coordinate points used in second or third generation pattern.
C	COUNT EXCEPT	Number of entries in an EXCEPT phrase exceeds one-half the total number of holes.

Examples of Preprocessor Error Detection

AUTOSPOT II Preprocessor

A. 1 REEERK/TAPE-O-MATIC-SAMPLE PROGRAM$
C UNDEF OPER REEERK /

B. 3 DASHA (3.0,0.0)
C FORM DEF

Explanation

A. Remark in statement 1, was spelled as REEERK.

B. A $ in statement 3, was not punched following the right parenthesis.

General Messages

In addition to the standard error messages, the following messages may appear:

STMT OFLO	A statement consists of more than five lines
TOOL 1234 TIPANG SET 118.0	Drill 1234 tip-angle missing, set to 118.0
TOOL 1234 EFFLENG SET 12.3456	Drill 1234 effective length missing, set to specified value
TOOL 1234 NO SS	A TOOL/ card has no spindle speed
TOOL 1234 NO FR	A TOOL/ card has no feed rate
TOOL 1234 NO CLT	A TOOL/ card has no coolant
END OF PREPROCESSOR	A Fini card has been found

ERROR MESSAGES -- (continued)

2. Specification Section

    ERROR DEFINITION SECTION

3. Machine Section

    1. ERROR MAJOR SECTION
    2. ERROR MINOR SECTION

4. Phase 2 Section

ERR 1 -	Unidentified Major Section Record Type
ERR 2 -	Tool Number not in Tool Table
ERR 3 -	Pattern Table Exceeded
ERR 4 -	Pattern Length Exceeded
ERR 5 -	Pattern Generation Exceeded
ERR 6 -	Pattern Operation Error

5. Post Processor Section

    1. DATA CHECK
    2. DASH ABSENT
    3. TABLE TRAVEL ERROR -- if the table travel distance has been exceeded -- to continue depress "start" the data in question is not punched on tape.

Section 1. Introduction

AUTOSPOT (AUTOmatic System for POsitioning Tools) is a general purpose computer program designed to aid the parts programmer prepare instructions for numerically controlled point-to-point machine tools. The parts programmer can describe the required operations in a familiar language, without calculations, repetitions, and the tedium of output format preparation.

Many of the words used here, and their meanings are similar to their use and meanings in other languages. This is a result of the universally accepted meaning of machining operations (i.e., the word DRILL has the same meaning regardless of the language involved or the machine tool used) and the authors'* efforts to make the AUTOSPOT language compatible with IBM's AUTOPROMPT and AUTOMAP.

AUTOSPOT provides a vocabulary sufficient for programming many point-to-point machining tools. The General Program (GP) output is in the same basic format without regard to the machine tool programmed. Machine tool oriented Post Processors are then used to convert the AUTOSPOT GP output to the individual machine tool format.

While AUTOSPOT reduces the effort and time required to write a numerically controlled machine tool program, it is not intended that this program replace good programming techniques. The authors emphatically endorse numerical control dimensioning, sound tool engineering analysis, and various other optimal programming methods.

To facilitate the implementation of the program, it is recommended that the most straight-forward programming method of the several applicable alternate techniques described in this manual be employed. To prevent the addition of any unwarranted complexity to the programming effort, it is imperative to choose the application most consistent with the intended usage.

The Post Processor is specifically oriented towards a particular machine tool. The output data from the GP Processor is converted into the format specified by the machine tool builder. Computations applicable to the various machine tools are also performed. A detailed discussion of these functions may be found in the Post Processor Manuals.

Section 2. AUTOSPOT Format

The input statement format is divided into three general sections; Definition, Tool Information, and Machining.

Each statement written in the part program is assigned a number for identification. This number is written in the first five columns which are not interrogated by the program. The statement structure is of the variable length sentence form, and requires punctuation that will be discussed later in detail. Each statement must have an end of line mark ($) to signify the end of the statement. There are seventy-five (75) spaces on the AUTOSPOT Form where the statements are written. If a statement is not completed in the amount of

* International Business Machines

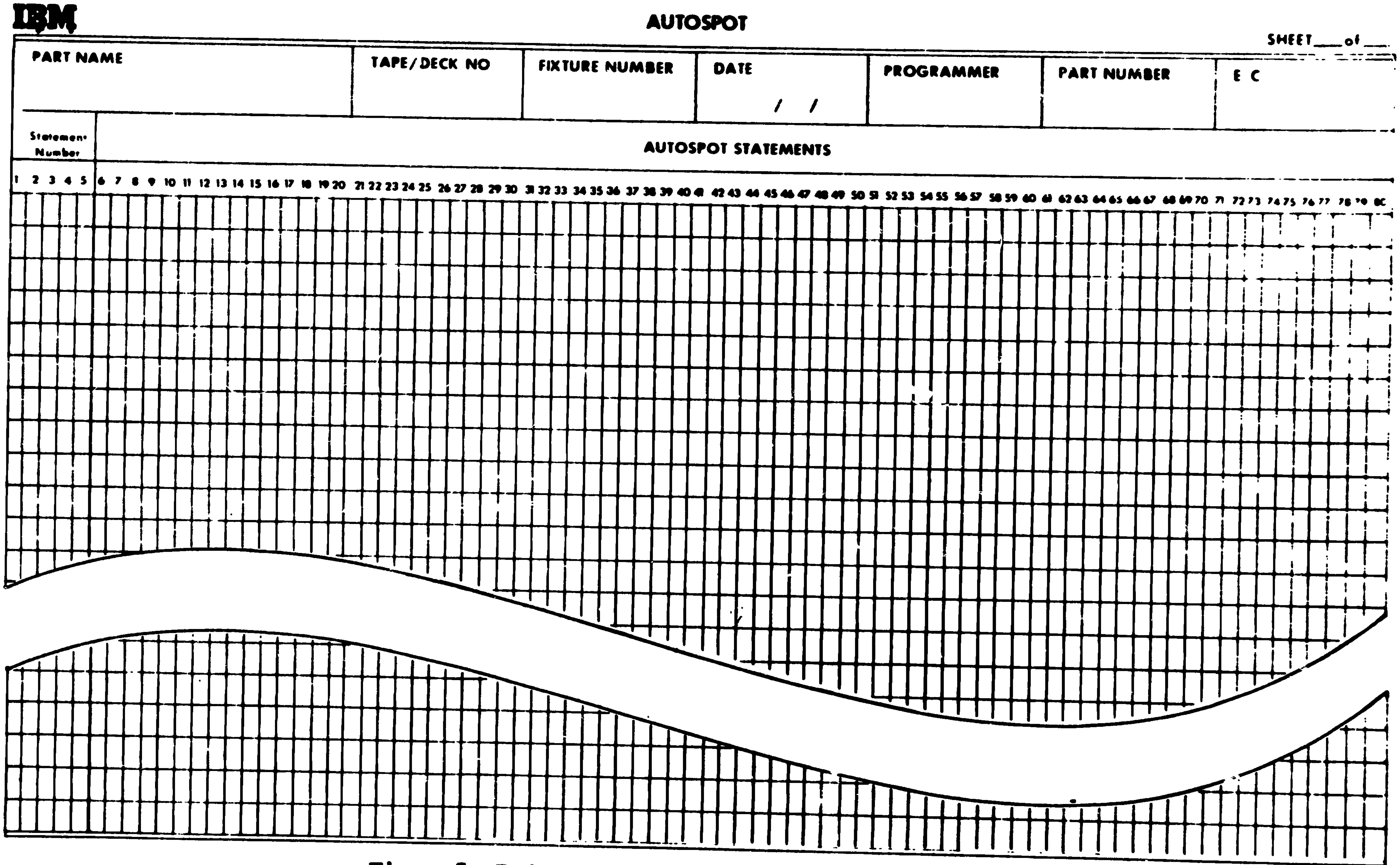


Figure 5. **Definition and Machining Statement Format**

space, a continue on the next line mark (*) must be inserted.

The words and language required by the program will be developed as each item of concept is discussed. A complete listing of the language and its meaning may be found in the appendix.

A. Definition Section (see figure 5)

The Definition Section is concerned with the machine tool and the part. It contains such information as:

1. Part location
2. Pertinent remarks
3. Tool clearance
4. Special cutting sequences
5. Reference surfaces

Definition Statements are retained in computer storage and referred to during processing. These statements are the first portion of input received by the data processing system. The following are examples of definition statements:

1. REMARK/MOUNTING 12423034 J DOE 10-11-33$
2. DASH A (10.5, 4.0)$
3. REMARK/TP (12.000, 4.000)$
4. START$
5. DASH B=DASH A (2.0 4.0)$

B. Machining Section

The information written in the Machining Section pertains to the specific operations required to machine the part. This Section must be preceded by the word START$. Each statement in this section is written in the form of a variable length sentence. The structure of this sentence is as follows:

Symbol = Major Section/Minor Section/Auxiliary Section

1. Symbol

The Symbol is a symbolic address or name which the programmer assigns to a statement. It signifies to the computer that the Symbol and its associated Minor Section information is to be retained in storage. A statement need not have a Symbol or Name; although, only those statements which are identified in this manner will have the Minor Section information retained. Using a symbol "after" it has been defined will cause the computer to recall the proper Minor Section information. The computer will "not" store Major Section and Auxiliary Section information; this data must be entered on the format each time it is needed.

2. Major Section

The Major Section of a statement contains descriptive operation information. This section is composed of the following information: operation description, tool number:

DRILL, 2604

The nature of this information is such that it describes a particular machining operation, and is not repeated. Therefore, the computer will not retain this information after it has been used.

3. Minor Section

The Minor Section of a statement is composed of numeric data pertaining to coordinate locations of the various points to be machined. It may include:

a. Surface referencing
b. X, Y, and Z coordinate values
c. Angular and polar notations
d. Routine descriptions
e. Routine exceptions
f. Pattern positioning and manipulation

The Minor Section must always be preceded by an oblique mark (/) to distinguish or separate it from the Major Section of the statement. Only Minor Section information in a statement identified with a Symbol will be retained in storage. All other Minor Section information must be repeated when it is required.

4. Auxiliary Section

The Auxiliary Section is used to introduce special instructions in the statement. These instructions specify the manner in which the operation is to be performed.

The Auxiliary Section must always be preceded by an oblique mark (/) to distinguish or separate it from the Minor Section of the statement. Auxiliary information is "not" retained in storage, and must be entered each time this type of information is desired. The machining depth (DP) and the feed rate (FR) are given in this section.

C. Punctuation

Statements written by a parts programmer in the AUTOSPOT language have two forms. The Tool Information Form is a fixed format, requiring information in a specified order and location, with no punctuation required. All other statements are written in a variable length sentence format and require punctuation to separate the various words from each other. The symbols used are as follows:

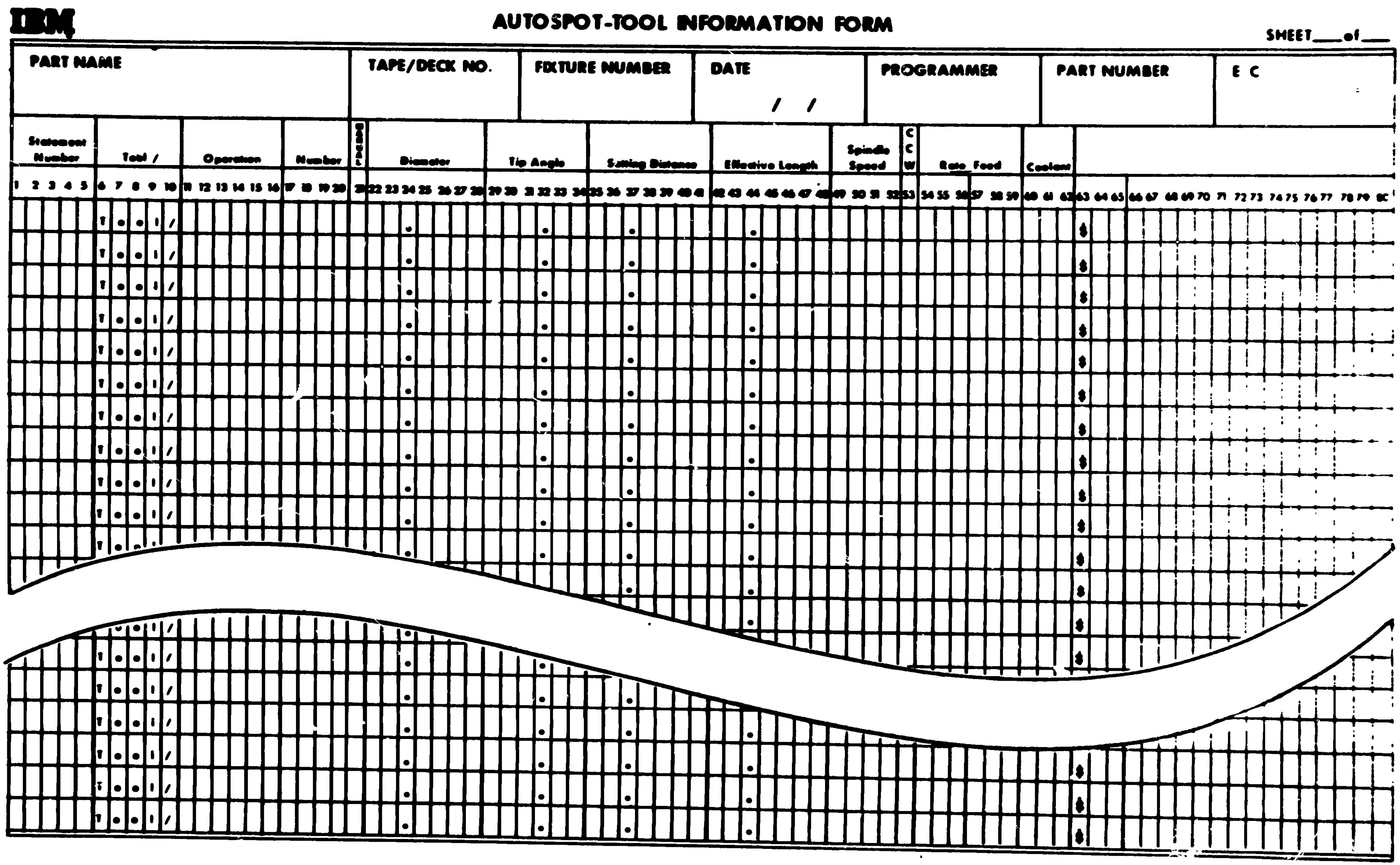


Figure 6. **Tool Information Format**

1. = The equal sign is used to separate a Symbolic Address from a Major Section.

2. / The oblique mark separates the Major Section from the Minor Section, and the Minor Section from the Auxiliary Section.

3. () Parentheses are used about a rough and finish amount, coordinate dimensions, angles and Auxiliary Section data.

4. . The Decimal Point is used in the mathematical sense; to separate numbers of units and tenths.

5. , The Comma is used wherever no other form of punctuation exists.

6. * Continue on the Next Line is used to indicate that the statement is not complete, and that additional information will be input on the next line. This symbol may be placed before or after any phrases in a statement.

7. $ The End of Statement must be written at the completion of every statement.

Section 3. Tool Information

The second item in the Major Section of each statement is a tool number. This number refers to a specific cutting tool on the machine for which the program is written. It may be composed of up to two letters for four numbers. When a letter is used, it may be followed by only one number or letter. Typical tool numbers may be: 1, 12, 123, 1234, A, AB, A1, etc. This notation is used to define a particular tool or tool holder location as the machine may require. TOOL cards are placed in the Definition Section and are followed by the START$ command.

A. Tool Information

Cutting tool data is required by those Numerical Control Machine Tools having tape controlled speeds, feeds, and variable Z axis control, and is written in the Tool Information Section. The format of the Tool Information Form is fixed, with entries inserted only where necessary.

During the machining portion of the program, tool information is utilized by calling out the specific tool and its number. This information is then considered in any required computations. Modifications to spindle speed and feed rate may be made by writing the new values in the Auxiliary Section of the applicable statement. These modified values will hold for the particular statement only, and are discarded upon its completion.

Section 3. Tool Information -- (continued)

It may be found convenient to establish a file of coded tool cards. The code refers to the tool description and the tool number, which in turn identifies the remaining information required. These cards may then be inserted in the Tool Information portion of each program in which they are to be employed. However, caution must be exercised when following this procedure since speeds and feeds will vary with the type of material and the machining operation. Figure 6 is an illustration of the Tool Information Format. Tool Information is listed in Table 2.

Table 2. Tool Information

INFORMATION	WORD	DESCRIPTION
Operation	DRILL	DRILL
	SPDRL	SPOTDRILL
	CSK	COUNTERSINK
	SPMIL	SPOTMILL
	BORE	BORE
	BOREOS	BORE-ON SPINDLE
	CBORE	COUNTERBORE
	REAM	REAM
	TAP	TAP
	PUNCH	PUNCH
	OTHER	OTHER
	MILL	MILL
	PMILL	POCKETMILL
	FMILL	FACEMILL
Tool Number	0101	0101
	0604	0604
	3001	3001

Section 3. Tool Information -- (continued)

INFORMATION	WORD	DESCRIPTION
	1	1
	2	2
	A	A
	B	B
Manual Tool	M	MANUAL
Diameter	SIZE OR DIAMETER	Inches
Tool Tip	ANGLE	Degrees
Note: No angle information is required for flat tipped tools.		
Tool Length	SETTING DISTANCE	Inches
	EFFECTIVE LENGTH	Inches
Machining Specifications	SS	SPINDLE SPEED Revolutions per minute.
	CW - No entry	CLOCKWISE ROTATION
	CCW-L (for left)	COUNTERCLOCKWISE ROTATION
	FR	FEED RATE inches _ r minute
	COOLANT	MACHINE TOOL COOLANT CODES -- put 007 in card columns 60-62 for the Pratt & Whitney Drilling Machine.

Section 3. Tool Information -- (continued)

B. Setting Distance

Setting distance (SD) is the over-all length of the tool (and spindle) or that amount that extends beyond the Z "home" position, with the spindle fully retracted. Effective length (EL) is the setting distance of the tool less the chamfered or conical tip of the tool that is not normally considered when dimensioning depths. (See figure 7.)

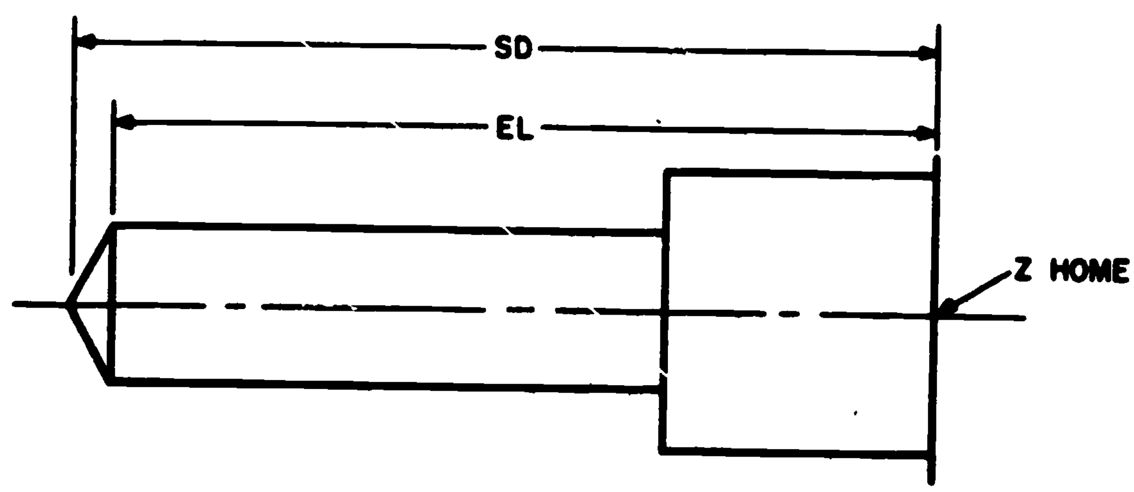


Figure 7. Setting Distance and Effective Length

Section 4. Axis Notation and Positioning

The Pratt & Whitney drill does not require the Z-Axis and Table Position (TP) information. This information would be required by a machine with a programmable Z-Axis. The general forms of the dash for the Pratt & Whitney will be:

1. DASH A (X, Y)$
2. DASH B = DASH A (X, Y)$

One of the principle functions of the Definition Section Statements is to establish the orientation of the part to the particular machine tool. Generally, no two parts will have the same referencing relationship.

A. DASH (DAtum Surface or Hole)

The word DASH signifies a Datum Surface or Hole. It is used to identify a reference point in three dimensions at one table position from which other points may be located by means of their change in dimension. The DASH value in itself is a reference of the "point" to the home position of the machine or spindle. Each DASH value is identified by a letter which may be chosen at random; however, X, Y, and Z may "not" be used.

To conform with Electronics Industry Association (EIA) proposed standards, the Cartesian Coordinate Axes system has been employed by this program. These axes are illustrated in figure 8. In all cases a negative dimension is used to indicate a direction parallel but in the opposite direction to the axis depicted.

The DASH information that identifies the location of a part with respect to the machine "home" may have either positive or negative dimensions. Depending upon the machine dimensioning system, the orientation of the coordinates and axis of any particular machine tool are compensated for by the particular post processor. This gives the programmer the ability to dimension all parts by one system, the EIA Standard. (<u>All dimensions are in inches.</u>)

1. <u>DASH Statements in the Definition Section</u>

Dash defines the part to machine relationship. A DASH statement is required for each vertical table position in which work is to be performed. A maximum of ten DASH surfaces may be employed in any one program. The statement is written as follows:

DASH A (X, Y,Z) TP(n)$

DASH A (10.0, 2.0, -18.75) TP (0)$

DASH F (9.0, 2.0, -17.75) TP (4)$

Description: In table position 0, the coordinate axis origin of the part with respect to the work table and machine is placed at X = 10.0, Y = 2.0, and Z = -18.75. In table position 4 the relationships are X = 9.0, Y = 2.0, and Z = -17.750. These coordinates are dimensioned from the "home" position of the machine.

Additional sets of coordinates required on a machining surface can also be defined by use of DASH. The coordinates inserted are in the amount of the actual change in X, Y, and Z from the original DASH.

DASH B = DASH A (X, Y, Z)$

DASH B = DASH A (2.0, 0.0, 1.0)$

DASH G = DASH F (0.0, 2.0, 0.0)$

Description: DASH B, a coordinate point in table position 0 at (12.0, 2.0, -17.75) is derived as follows:

DASH A = (10.0, 2.0, -18.75) TP (0)

DASH B = DASH A <u>(2.0, 0.0, 1.0)</u>

DASH B = (12.0, 2.0, -17.75) TP (0)

DASH G is a coordinate point, in table position 4, at (9.0, 4.0, -17.75).

The new coordinate location is derived as follows:

DASH F = (9.0, 2.0, -17.75) TP (4)

DASH G = DASH F <u>(0.0, 2.0, 0.0)</u>

DASH G = (9.0, 4.0, -17.75) TP (4)

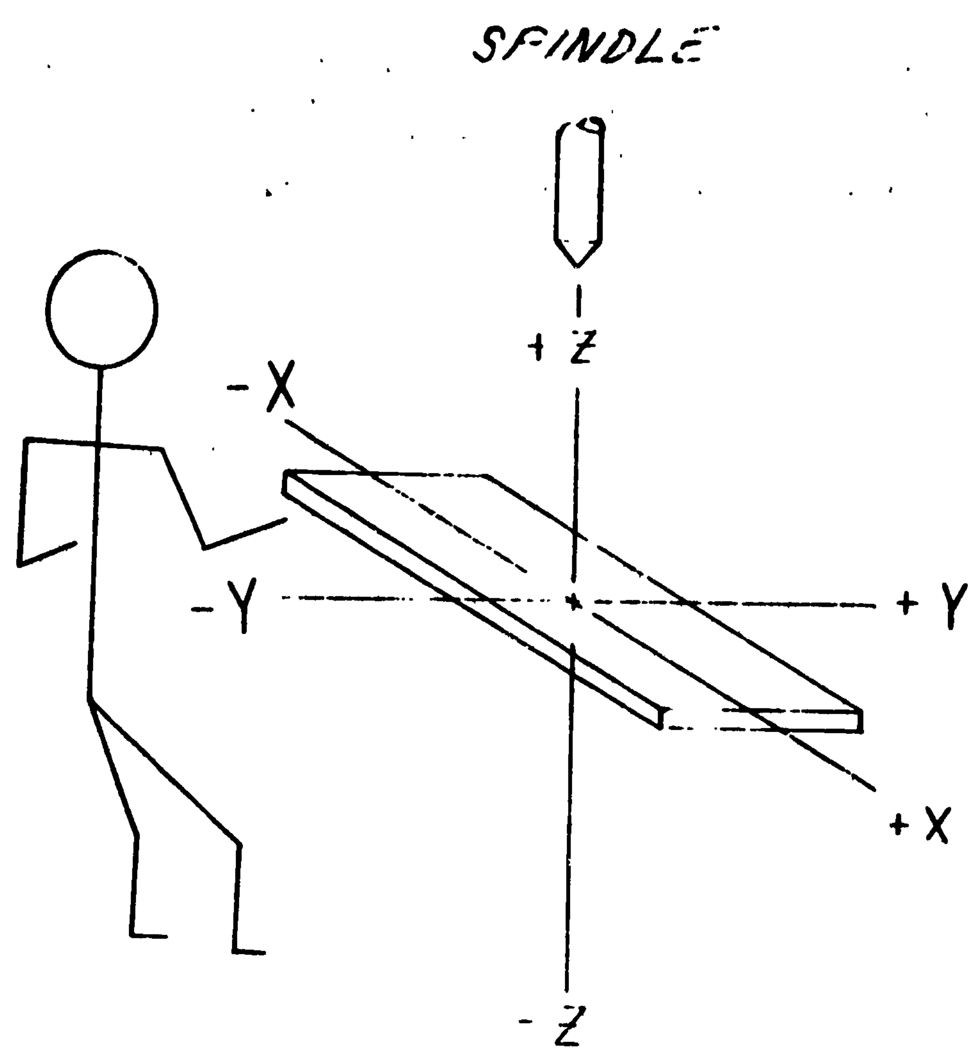
Note:

Some machine tools require DASH referencing in only two dimensions; X and Y. With this type of requirement the Z dimension may be omitted. However, both the initial and the referenced DASH must contain the "same" number of coordinates. In addition TP(n) may also be omitted when applicable.

B. Machine Axes

The Electronics Industry Association (EIA) has standarized the machine axis of numerically controlled machine tools by employing the Cartesian Coordinate Axes System*.

THE PRATT & WHITNEY DRILLING MACHINE



Machine Axes

* EIA Standard RS - 267, July, 1962

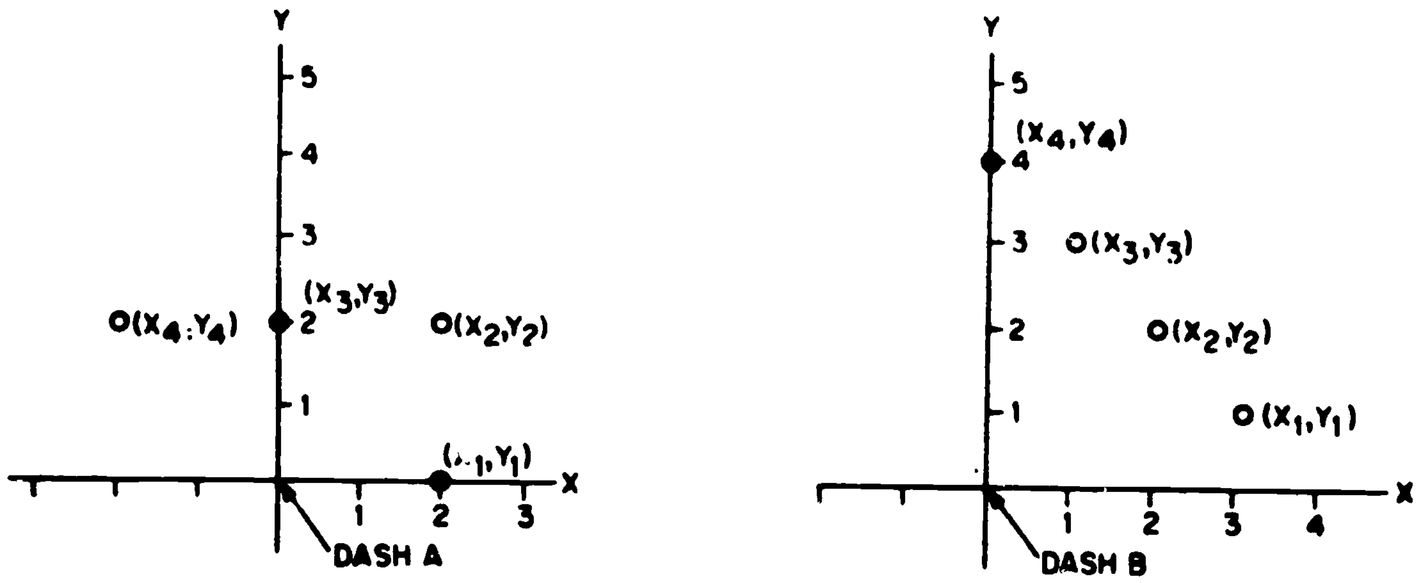


Figure 9. X-Y Coordinate Dimension

B. <u>Polar Coordinate Dimensions</u>

If a part print (figure 10) is dimensioned with polar coordinates (locations identified by a radius at an angle), the work address Minor Section may be written as follows:

/DAA, AT $(X_1, Y_1)R_1(\ )A_1(\ )R_2(\ )A_2(\ )R_3(\ )\ A_3$ etc.

/DAG, AT (3.0,1.0)R(3.0)A(30.0)R(3.5)A(45.0)*
R(4.0)A(150.0)

R = Radius **A = Angle**

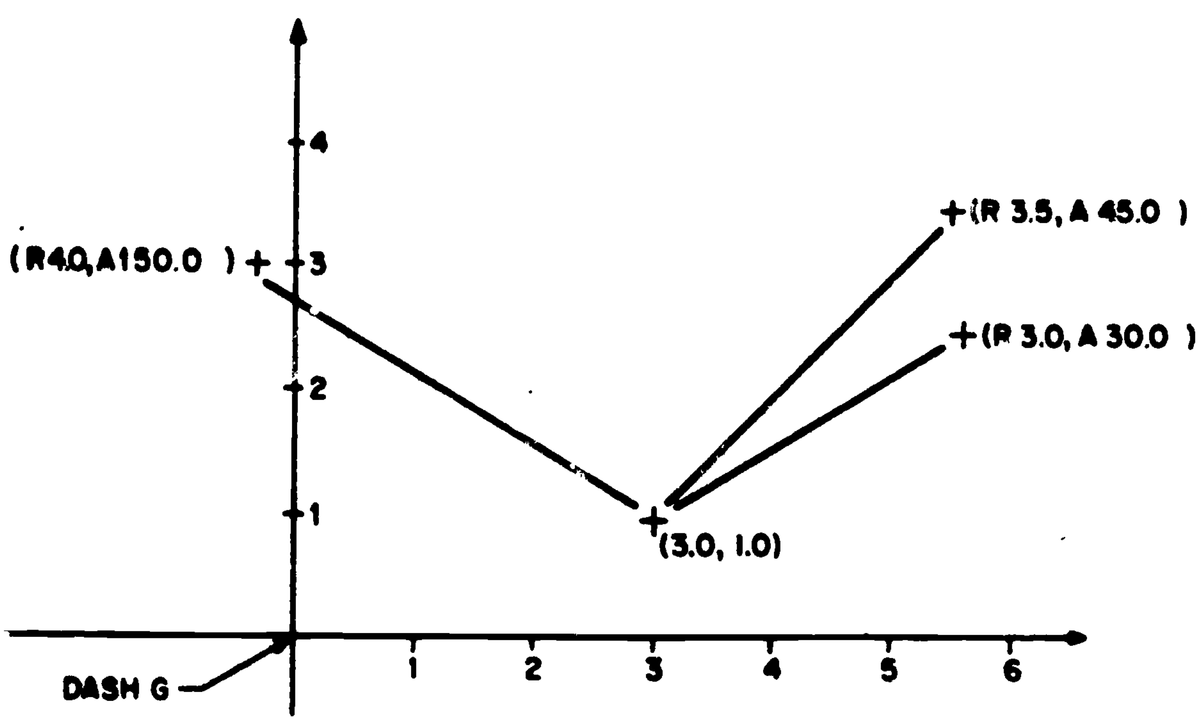


Figure 10. Polar Coordinate Dimensioning

In this example, the locations of the points are dimensioned from the point X = 3.0 and Y = 1.0, with respect to DASH G. All angles are measured in the counterclockwise direction from the positive X axis.

Section 5. Point to Point Operations

Machining operations performed at a fixed coordinate location are referred to as point operations. Here, the path taken to the point is relatively unimportant.

A. Operation Words

The nature of each operation and the tool number must be described in the Major Section of a Machining Statement; coordinate location information is written in the Minor Section. The point operations that are recognized by AUTOSPOT are (See glossary, Section 10, appendix A).

SPDRL

CSK

DRILL

BORE

BOREOS

CBORE

REAM

TAP

Each cutting operation word is followed by a comma and a tool number that corresponds to the tool number coding on the particular machine tool. This may be either the tool number or the tool holder number: the commands SPDRL and CSK must have tool cards in the Definition Section. The use of tool cards is more apparent in connection with other than the P-W drill.

BORE, A5
(Operation) (Tool No.)

Section 6. Patterns

A. Symbolic Address

A Symbolic Address in a Machining Statement is used to signify that the Minor Section of a statement is to be stored for reuse later in the program.

Statements may be addressed as required in the program.

```
PAT 1 = DRILL,0101/DAA (2.0,0.0) (2.0,2.0)(0.0,2.0)*
   (-2.0,2.0)/DP(0.210)$

PAT 2 = DRILL,0101/DAB (3.0,1.0) (2.0,2.0) (1.0,2.0)*
   (0.0,2.0)/DP(0.223)$
```

To recall the Minor Section, the statements are written as follows:

```
DRILL, 0202/PAT 1/DP(0.50)$

DRILL, 0202/PAT 2/DP(0.56)$
```

Description: Drill with tool number 0202 all holes described in the statement identified by PAT 1 to a depth of 0.5 inches. Drill with tool number 0202 all holes described in the statement identified by PAT 2 to a depth of 0.56 inches.

The Symbolic Address or name is not a fixed specific word. The program will recognize any word not exceeding five alphanumeric symbols (the first symbol is <u>always</u> alphabetic). The names used above were PAT 1 and PAT 2 where PAT was an abbreviation of pattern. Other Symbolic Addresses might be CIRC 5 (circle 5), LOC 11 (Location 11), etc., as the programmer desires. The numbering order is also insignificant. For example, PAT 8, can be defined prior to PAT 5. The Symbolic Address is merely a name that is identified with the Minor Section of a Statement.

B. Translation of Patterns

Translation is a method whereby a previously defined pattern may be rotated about some point and/or moved to a new location. A statement directing a translation is written in the following manner:

DRILL, 0101/PAT 1 (X_1, Y_1) AT (DEG)/DP(n)$

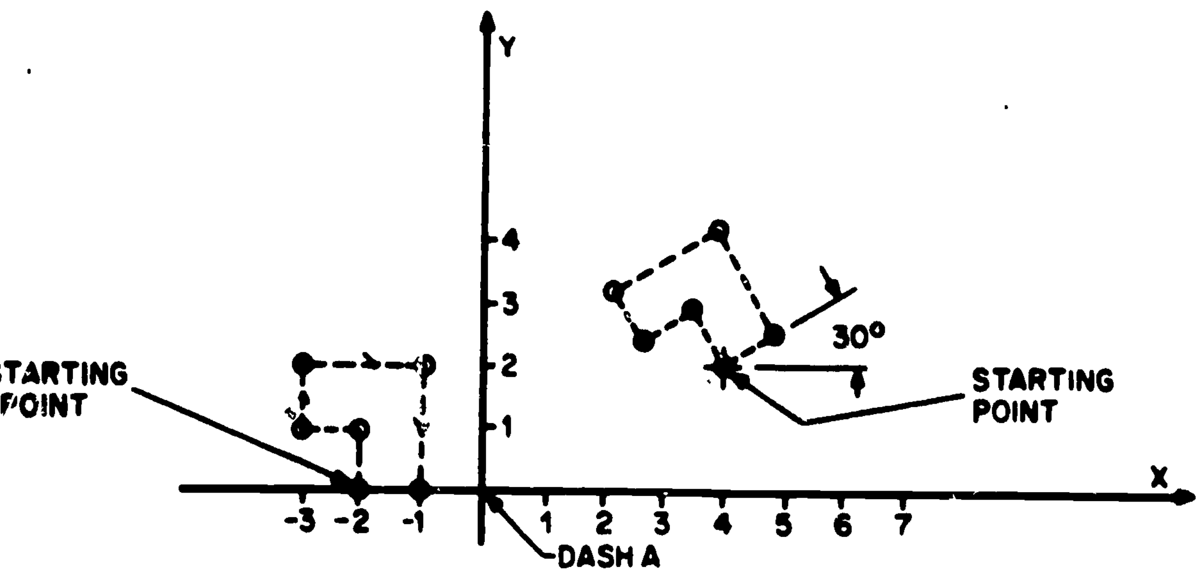
DRILL, 0101/PAT 1(4.0,2.0) AT (30.0)/DP(0.120)$

Description: This statement indicates that a drilling operation using tool 0101 is to be performed. Pattern 1 is to be relocated to location X = 4.0, Y = 2.0 and then rotated 30° in the counterclockwise direction. The starting point of the pattern is the center of revolution.

<u>Note</u>:

All angles are dimensioned from the positive X axis and in a counterclockwise direction. However, the angle used in pattern rotation is the change in the pattern's orientation, measured in the counterclockwise direction. No rotations of a rotated pattern are permitted.

In figure 20, it has been assumed that the first point of the original pattern with reference to DASH A was located at X = -2 and Y = 0. This point was then moved to the new location of X = 4, Y = 2. The rest of the points of the pattern were then rotated 30° about the starting point. It must be kept in mind that the starting point and rotation of the pattern at a new location will be about the first point of the pattern as it was defined previously. The program will determine the new coordinates for each point in the pattern.



PAT 5 = DRILL, 0101/DAA (-2.0, 0.0) (-2.0,1.0) (-3.0,1.0)*
(-3.0,2.0) (-1.0,2.0)(-1.0,0.0)/DP(0.1201)$

Figure 20.

Patterns may also be translated without a rotation. When this is desired, the new coordinate location is written in (as above), but the angle portion is omitted.

DRILL, 0101/PAT 5 (4.0,2.0)/DP(0.120)$

This statement would translate the above pattern to the same location, but without a rotation. The starting point is again at X = 4.0, Y = 2.0, but the pattern has the same relative position as the original.

Previously defined patterns can be relocated to a new set of coordinates on a new surface by use of statements similar to the following, provided that the new surface has been previously defined:

DRILL, 0101/DAC,PAT 1(2.0,1.0)/DP(0.210)$

Description: DRILL (with tool number 0101) pattern 1 at a new location where the first hole is 2.0 in X and 1.0 in Y from DASH C.

DRILL, 0101/DAF, PAT 2(1.5,2.5)/DP(0.223)$

Description: DRILL with 0101, pattern 2 at a new location on another surface. Place the first hole at 1.5 in X and 2.5 in Y from DASH F. All other holes will be in the relative position from the first hole as in the original pattern.

Note:

If in the preceding examples the patterns were to be repeated on their original surfaces, DAA and DAB would not have to be written since they were included in the previously defined patterns.

C. Reverse

The word used to reverse the sequence of operation of a pattern is REV.

PAT 1 = DRILL, 0101/DAA(X_1,Y_1)(X_2, Y_2)(X_3, Y_3)*
(X, Y)/DP(n)$

DRILL, 0202/REV, PAT 1/DP(m)$

Description: The second statement means drill the previously defined pattern 1 with tool number 0202 in reverse order beginning with hole (X_4,Y_4) and proceeding to (X_3, Y_3) etc.

D. Invert

When machining a part, the mirror image of a previously defined pattern may be required. To obtain such an image, the work INV (Invert) is written in the Minor Section of the statement, and is modified by R (right), L (left), U (up), or D (down), to indicate the direction in which the inversion is to be made. The inverted pattern is then relocated to the new locations by indicating the coordinates of the first point in the pattern.

DRILL, 0101/INVR, PAT 1 (X_1, Y_1)/DP(n)$

DRILL, 0101/INVR, PAT 1 (4.0, 2.0)/DP(0.220)$

Description: The operation of drilling with tool 0101 is to be performed. PAT 1 (previously defined) is to be inverted to the right with the first point located at X = 4.0 and Y = 2.0. (See figure 31.)

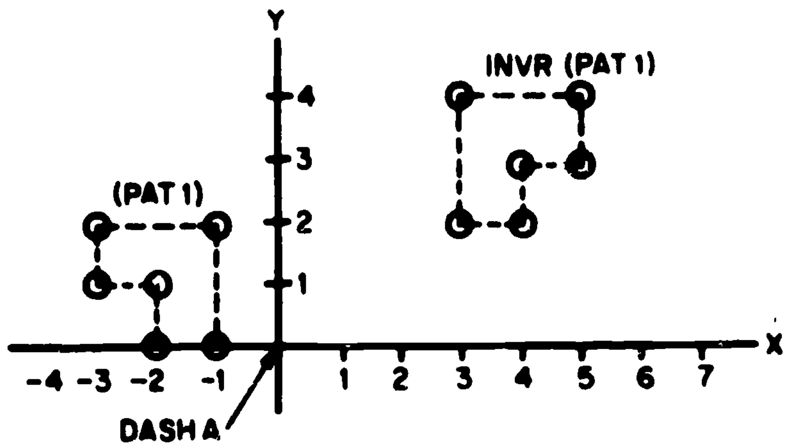


Figure 21. Pattern Inversion to the Right

By the same method, the pattern may be inverted to the left, up or down. A pattern may be inverted any number of times, but reference must always be made to the original pattern. This means that a pattern may not be inverted to the right and then down (actually a double inversion is the same as a 180° rotation). Figure 22 illustrates the possible inversions and their relationships.

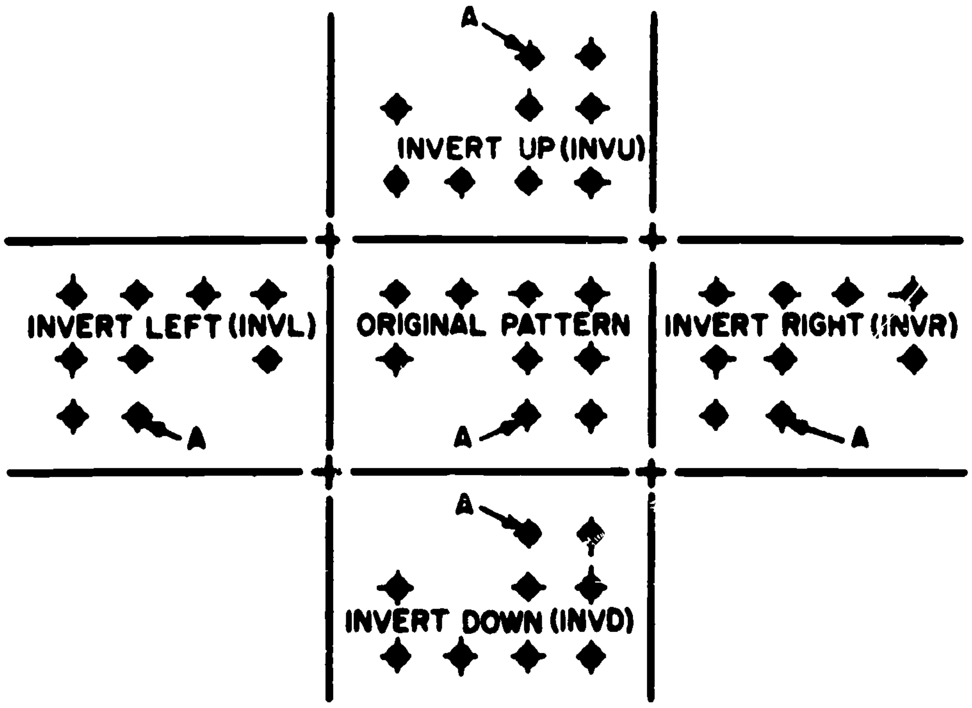


Figure 22. Possible Pattern Inversions

Table 3 indicates the variations encountered with path operations that have been inverted.

Table 3. Path Operations

Original Pattern Direction	Symbol	Inverted Path Direction
Horizontal Path	INVR	Opposite to original
	INVL	Opposite to original
	INVU	Same as original
	INVD	Same as original
Vertical Path	INVR	Same as original
	INVL	Same as original
	INVU	Opposite to original
	INVD	Opposite to original

The R,L.D, or U included in the symbol INV will indicate to the computer which inverted path direction rule must be employed. To do this, the computer must refer to the original pattern to determine the path director of the various moves. This necessitates the exclusion of an inversion on an inversion.

When a path operation is inverted, the manner of cutting (climb or conventional is reversed. An original operation employing climb milling will result in conventional milling operation when inverted, and vice versa. Therefore, when a milling operation is inverted, the sequence of operations is automatically reversed so as to retain the type of milling originally specified.

E. <u>THEN Connector and Auxiliary Section Manipulation</u>

The word THEN is used to connect two or more Minor Sections with the same Major Section of a Machining Statement.

DRILL, 0202/PAT 1/DP(0.50) THEN,PAT 2/DP(0.56)$

Description: Drill pattern 1, with tool 0202, to a depth of 0.500 and then pattern 2 to a depth of 0.560.

With this type of a statement, it may be necessary to include Auxiliary information for each Minor Section. If this is the case, it is written in the manner illustrated above.

Some statements may be constructed in which several Minor Sections require the same Auxiliary Section. The following THEN connected Minor Sections will all have the preceding Auxiliary Section implied until a Minor Section is written with another Auxiliary Section. This Auxiliary Section will then be applied to any following Minor Sections:

Major Sect/Minor Sect #1/AUX #1 THEN, Minor Sect #2 THEN,*
Minor Sect #3/AUX #2 THEN, Minor Sect #4 THEN, Minor *
Sect #5 $

Description: In the above example, the first Minor Section is appended with Auxiliary Section #1. Since Minor Section #2 does not have an Auxiliary Section, Auxiliary Section #1 is employed. Minor Section #3, has Auxiliary Section #2, which is also used by Minor Sections #4 and #5.

The first Minor Section of any statement must have an Auxiliary Section. Additional Minor Sections may be attached to the statement by means of the THEN connector. If Auxiliary Sections are not written for these additional Minor Sections, the preceding Auxiliary Section will be applied. The maximum number of X, Y, and Z coordinates allowed in a Minor Section is twenty-five. A then connector is required for additional points in the statement.

Examples:

1. DRILL, 0101/DAA(5.0,5.0)THEN, PAT 1(6.0,6.0)$

2. DRILL, 0102/DAA(5.0,5.0)THEN, PAT 1, THEN, DAA(6.0,6.0)$

3. DRILL, 0103/PAT 1, THEN, DAA(7.0)$

4. DRILL, 0104/PAT 2(6.0,6.0)THEN, DAA(7.0,7.0)$

5. DRILL, 0105/DAA(1.0,1.0)(2.0,2.0)THEN, DAB (3.0,3.0)(4.0,4.0)$

F. Higher Level Patterns

A machining statement written with X, Y coordinate location data in the Minor Section and identified by a Symbolic Address such as PAT 5 is called a first level pattern. This is a statement containing X and Y data.

PAT 5 = DRILL,0289/DAA (X, Y)(X, Y)/DP(n)$

PAT 5 = DRILL,0287/DAA (1.0,1.0)(2.0,2.0)(3.0,3.0)*
/DP(0.55)$

A second level pattern is created when a statement, containing a first level pattern in the Minor Section, is identified by another name such as PAT 6.

PAT 6 = DRILL,0287/DAB,PAT 5/DP(0.55)$

A third level pattern is created when a statement containing a second level pattern is assigned a name.

PAT 7 = DRILL,0287/DAC, PAT 6/DP(0.55) THEN,*
DAD, PAT 6$

A statement increases its level whenever it is Symbolically Addressed. The level is one higher than the highest level pattern contained in the Minor Section and the third level pattern is the highest order that may be generated.

Close attention is required when utilizing third level patterns. As in other pattern levels, the Major and Auxiliary Sections are not retained in storage. When the pattern is called out, the Major and Auxiliary sections written in the new statement apply to everything contained in the Minor Sections. Therefore, all locations will be operated upon by the same tool, to the same depth or diameter, and the same relationship between the various locations as originally established is maintained. (See figure 23.)

DRILL, 1011/PAT 7/DP (0.75)$

The limitations with higher level patterns are as follows: A higher level pattern may not be defined when the statement contains patterns of different levels. For example, a third level pattern may not be defined when first and second level patterns are written in the Minor Section of the Statement.

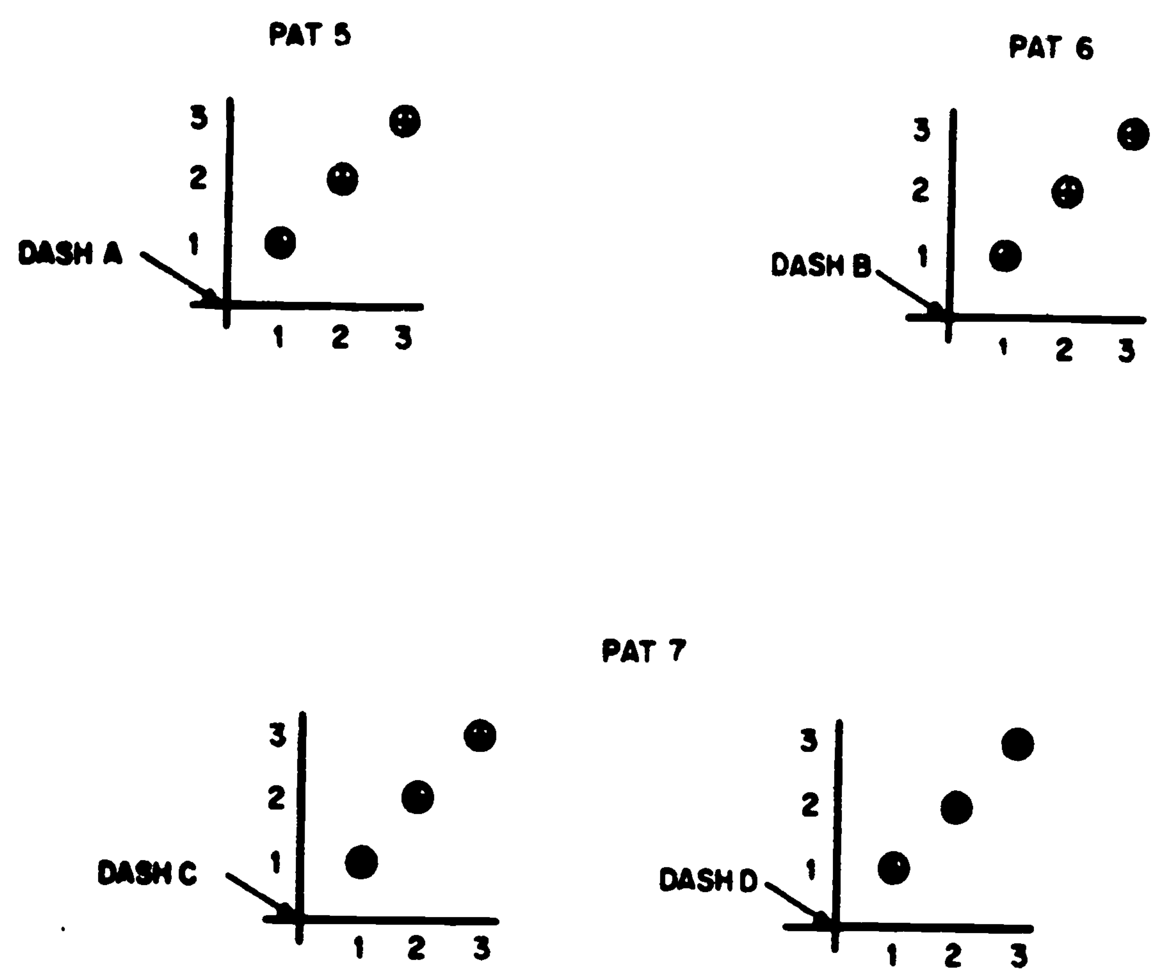


Figure 23. Higher Level Patterns Using Example Statements

1. First Generation Patterns - First generation patterns may be defined on any DASH surface and are oriented relative to the first point (also referred to as the transform function). First generation patterns may be translated, inverted, and/or rotated on any DASH surface by specifying the new surface, direction of inversion, transformed function, and/or angle of rotation. The angle of rotation is always interpreted as a positive angle measured in a counter-clockwise direction from a horizontal line through the first point. Any number of first generation patterns may be output in a single machining statement by use of the "THEN" connector. First generation patterns may be reversed, but no other operation may be performed simultaneously with a reversal.

2. Second Generation Patterns - Second generation patterns are constructed of one or more first generation patterns which have been linked in a series with the "THEN" connector, and have been defined to be a pattern of the next generation.

   When a second generation pattern is recalled in a machine operation the entire pattern is positioned at a new location. A new DASH surface, start point, direction of inversion, and/or angle of rotation may be specified. In the event that a new start point has been directed the pattern routine will place the first sub-pattern (a first generation pattern) of the second generation pattern at the specified point. The location of each of the additional sub-patterns will be fixed relative to the start point of the first sub-pattern.

   In order to maintain the relative positioning between sub-patterns a "difference transformation" or linkage must be computed for each sub-pattern which has been linked by the "THEN" connector. The difference transformation is computer by algebraically subtracting the coordinates of the start point of the first sub-pattern from the start point of each succeeding sub-pattern. This difference is then added algebraically to the start point specified in the machining statement and the resulting transformation is used to produce the desired machining locations. This procedure is repeated until the second level pattern has been completely output.

   It is also noted here, that a pattern of any level may be rotated, but the routine will reject the rotation of a pattern which has one or more sub-patterns of any level which require a rotation. The same rule applies for inversion, but does not imply that an inverted pattern may not be rotated. It is further stimulated that only first generation patterns may be reversed. Users of this program are advised to exercise caution in operating with a pattern which has sub-patterns defined on more than one different DASH surface. If a machine statement includes a new DASH surface then the program will assume this surface for all of the sub-patterns in the higher generation pattern.

3. Third Generation Patterns - Third generation patterns may consist of sub-sets second generation patterns. The rules for handling third generation patterns are an extension of the rules for second generation patterns. If in a machining statement a third generation pattern is relocated at a new first point then this becomes the first point of the first sub-pattern (second generation pattern). For each subsequent sub-pattern a linkage must be computed in order to maintain the desired relationship of all sub-patterns relative to the first. When the first point of each second generation sub-pattern is located then the procedure for generating machining points for second generation patterns is executed. Note that a difference transformation must be computed to link the sub-patterns of a third generation pattern, and that a second difference transformation must be computed to position the sub-patterns of the successive second generation patterns.

   A third level pattern may be included in a machining statement with or without a new first point. In this case, the pattern operation becomes a series of "THEN" connected first and second level patterns. Section - <u>Defines, Operations and Restrictions</u> defines some operations, and restrictions.

<u>Defines, Operations and Restrictions</u>

1. <u>Basic Pattern Defines</u>

   a. PAT 1 = /DAA (X,Y)
   b. PAT 2 = /DAA (X,Y) (X,Y)...
   c. PAT 3 = /DAA (X,Y) (X,Y)...

2. <u>Allowable Operations With First Generation Patterns</u>

   a. DRILL/PAT 1
   b. DRILL/PAT 1 (X,Y)
   c. DRILL/PAT 1, AT (180.)
   d. DRILL/REV, PAT 1
   e. DRILL/PAT 1 (X,Y) AT (180.)
   f. DRILL/INVR, PAT 1 or INVL or INVU or INVD
   g. DRILL/INVR, PAT 1 (X,Y)
   h. DRILL/INVR, PAT 1 (X,Y) AT (180.)

3. <u>Second Generation Defines</u>

   a. PAT 4 = PAT 1 (X,Y) THEN,PAT 2 (X,Y) THEN...
   b. PAT 5 = REV, or INVR, PAT 2 (X,Y) at (180.) THEN
      REV, or INVR, PAT 3 (X,Y) AT (180.) THEN . . .

4. <u>Allowable Operations With Second Generation Patterns</u>

   a. DRILL/PAT 4
   b. DRILL/PAT 4 (X.Y)

c. DRILL/PAT 4,AT (180.)
d. DRILL/PAT 4 (X,Y) AT (180.)
e. DRILL/INVR, PAT 4 or INVL or INVU or INVD
f. DRILL/INVR, PAT 4 (X,Y)
g. DRILL/INVR, PAT 4 (X,Y) AT (180.)

5. Third Generation Defines

a. *PAT 7 = INVR, PAT 4 (X,Y) AT (180.) THEN,INVR,
PAT 4 (X,Y) AT (180.) THEN...

*Note that the third generation pattern defined in the example has only second generation sub-patterns.

6. Allowable Operations With Third Generation Patterns

a. DRILL/PAT 7
b. DRILL/PAT 7 (X,Y)
c. DRILL/PAT 8,AT (180.)
d. DRILL/PAT 8 (X,Y) AT (180.)
e. DRILL/INVR, PAT 8 or INVL or INVU or INVD
f. DRILL/INVR, PAT 8 (X,Y)
g. DRILL/INVR, PAT 8 (X,Y) AT (180.)

7. Restrictions and Remarks on Pattern Operations

a. No reversal of a second or third level pattern.
b. No inversion of a previously inverted pattern.
c. No rotation of a previously rotated pattern.
d. No pattern define greater than third generation.
e. Approximately (5000) total locations available for pattern storage.
f. Maximum of (1000) locations available for individual pattern.
g. If pattern storage rules are violated then program will be terminated.
h. Program will stack any number of jobs and will restart on a code ($\overline{9}$9).

Section 8. Routines

Included in the AUTOSPOT Program are routines that are capable of generating coordinate locations from an abbreviated input. However, the formats of these statements are fixed, requiring that each item of information be written in the proper sequence in the Minor Section. The Major and Auxiliary Sections are not affected.

A. Bolt Circle Programming

The words used to program a bolt circle and their description are as follows:

1. AT (X,Y) - Coordinates of the center of the circle.

Section 8. Routines -- (continued)

2. R - Radius in inches.

3. SA - Starting Angle in degree measured ccw from the + X axis.

4. IA - Incremental Angle in degree between points on the circle.

5. NH - Number of Holes required on the circle.

DRILL, 0101/DAA, AT (X,Y)R(n)SA(n)IA(n)NH(n)/DP(n)$

DRILL, 0101/DAA, AT (1.5,1.5)R(1.25)SA(0.0)IA(30.0)*
NH(12)/DP(0.223)$

Description: A drilling operation using tool 0101 is to be performed to a depth of 0.223 inches. The format of the Minor Section indicates a bolt circle with the center located at X = 1.5 and Y = 1.5. The radius of the circle is 1.25 inches. The first hole is at zero degrees from the X axis, and twelve holes equally spaced at thirty degrees are desired. This is all the information req·ired to produce the operation (See figure 24.)

The starting Angle (SA) of the bolt circle need not be at zero degrees. Similarly, the Number of Holes (NH) can be less than maximum to obtain a portion of the bolt circle. Also, it should be noted that the coordinate center is merely a reference point at which no machining is performed.

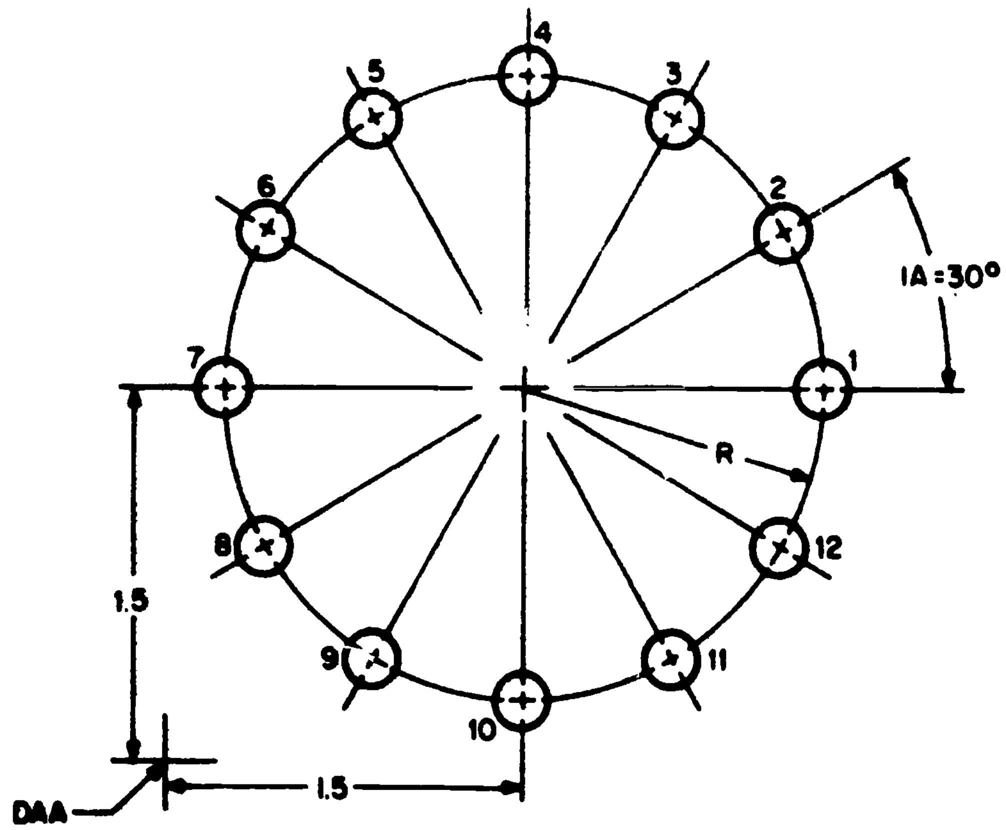


Figure 24. Bolt Cir^le

```
DRILL, 1242/DAB,AT(3.2,1.7)R(1.875)SA(15.0)IA(37.5)*
    NH(5)/DP(0.53) $
```

Description: A bolt circle is to be drilled using tool 1242. The center of the circle is at X = 3.2 and Y = 1.7 inches from DASH B. Five holes to a depth of 0.580 inches are desired at an incremental angle of 37.5 degrees with the first hole at 15.0 degrees. (See figure 25.)

Note:

Bolt circle points are counted counterclockwise beginning with one at the start angle location and all angles are measured in a counterclockwise direction.

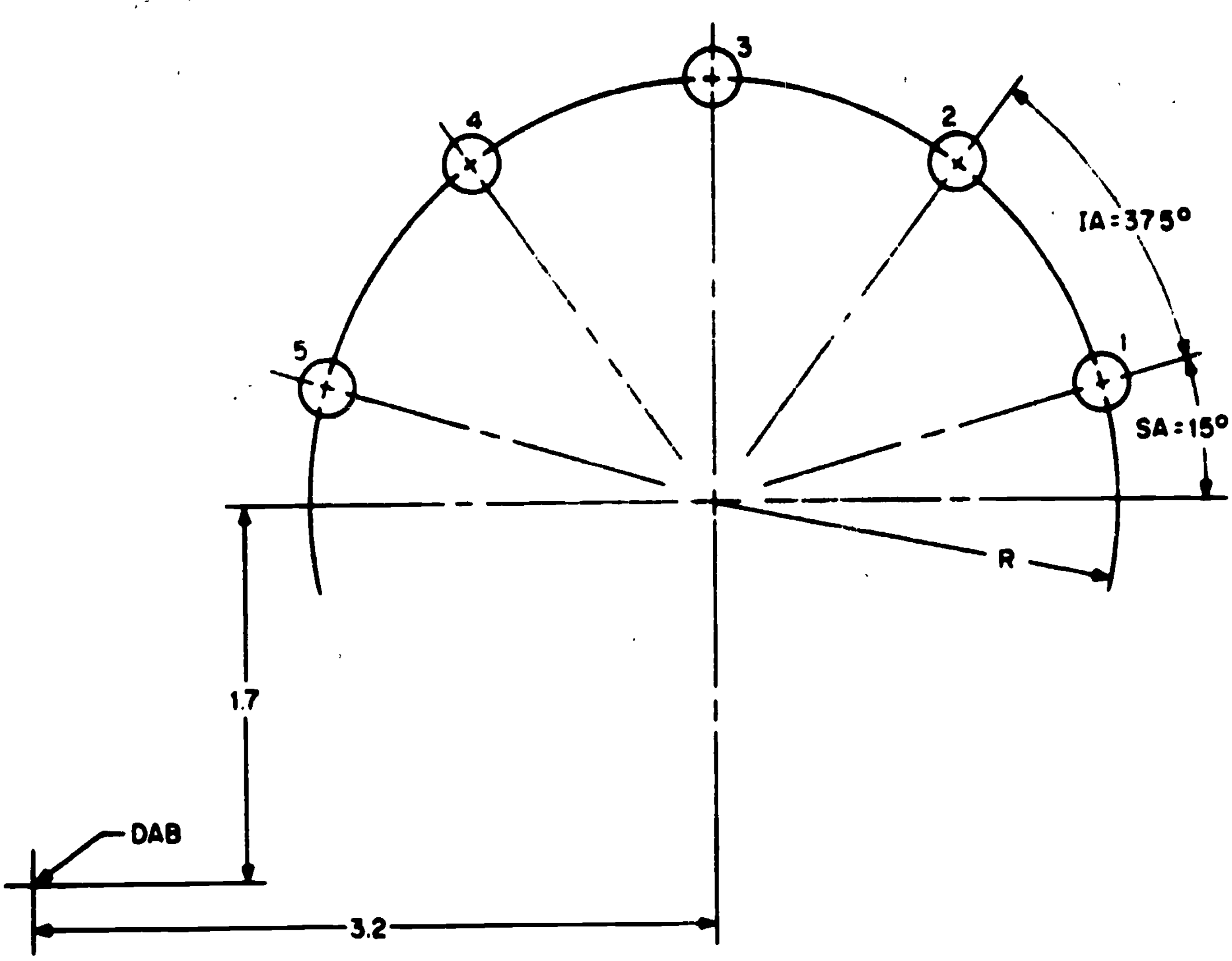


Figure 25. Bolt Circle

B. Incremental Programming

This programming technique generates points that are equally spaced from each other. The words used in the Minor Section of a statement are:

1. SX - starting point in X

2. SY - starting point in Y

3. EX - ending point in X

4. EY - ending point in Y

5. NH - number of holes

```
DRILL, 3034/DAC, SX(6.0) SY(4.0) EX(0.0) *
      EY(2.0) NH(5)/DP(1.0) $
```

Description: Drill with tool 3034, the increment identified in the Minor Section to a depth of one inch. There are five holes required and they are equally spaced between the points X = 6.0, Y = 4.0 and X = 0.0, Y = +2.0, referenced to DASH C. (See figure 26.)

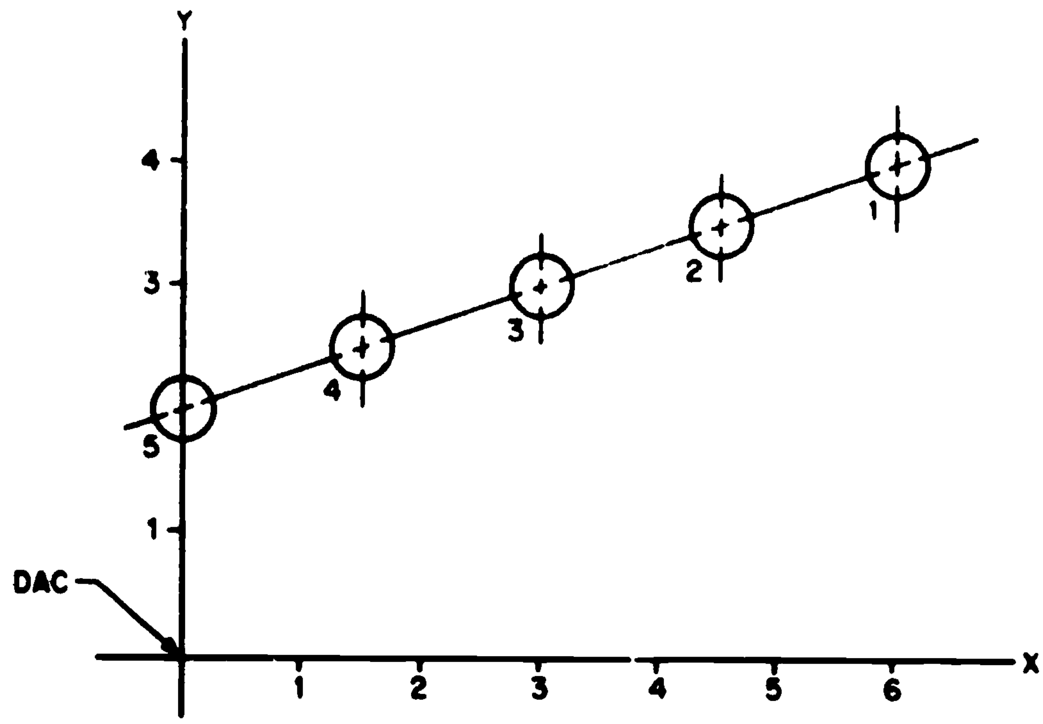
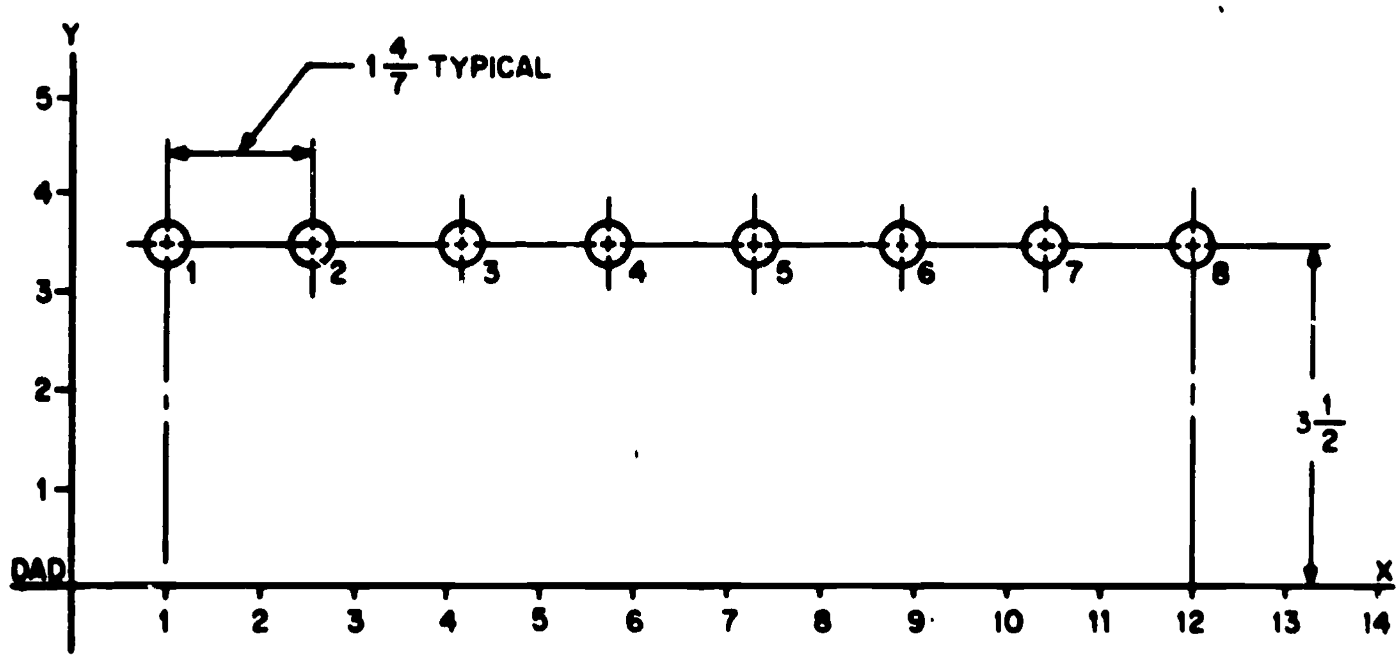


Figure 26. Incremental Programming

Both the Ending X (EX) and Fnding Y (EY) are required when the values differ from the starting point. However, if a location parallel to an axis is required, there is no change in value for one of the ending points, and this value is not written. (See figure 27.)



DRILL, 3400/DAD,SX(1.0) SY(3.5) EX(12.0) NH(8)/DP(0.65)

Figure 27. Incremental Programming

An increment of an Increment or a matrix can be programmed in two statements. (See figure 28.)

```
PAT 11 = /DAD,SX(1.0) SY(3.5) EX(12.0)NH(8) $

PAT 12 = DRILL, 3400/PAT 11, SX(1.0) SY(3.5) EY(6.0) *
   NH(4)/DP(0.375) $
```

Note:

The maximum number of holes in an increment is thirty-two. Therefore, a matrix could produce 1024 hole locations.

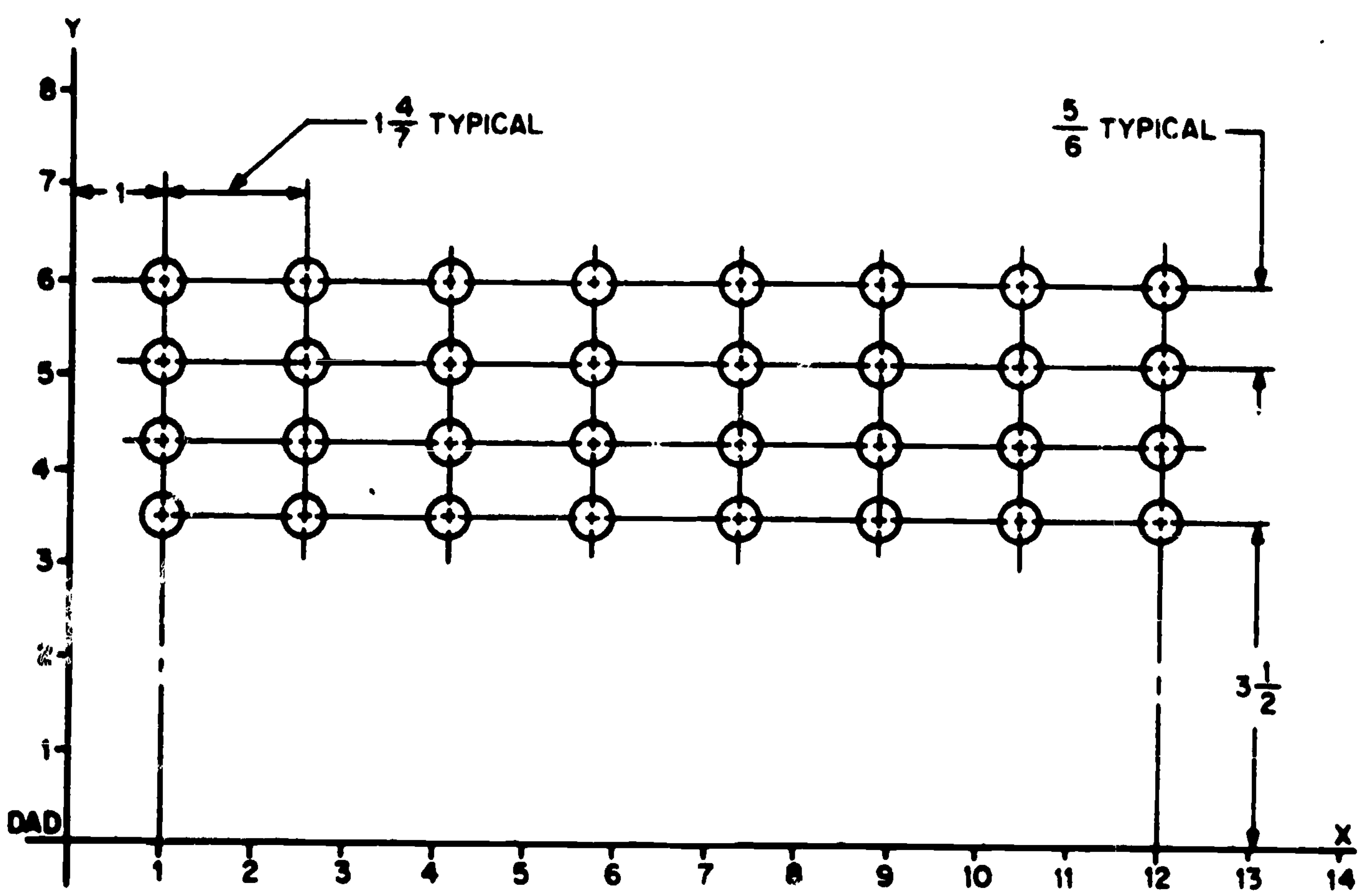


Figure 28. Increment of an Increment or Matrix Programming

C. EXCEPT

The two preceding articles (Bolt Circle Programming and Incremental Programming) pertain to methods whereby a series of coordinate locations may be generated and operated upon. In some applications, it may be determined that not all the generated locations are desired. EXCEPT is a word that gives the parts programmer the ability to exclude the undesired locations from the program. For example in figure 29 a series of eight holes on a line are required. The first four are equally spaced from each other, as are the remaining. These two groups are separated from each other by a distance equal to twice the spacing.

In this problem, the holes are numbered, as in the illustration, with an imaginary hole 5. The statement would then be written to drill all the holes (EXCEPT 5), thereby achieving the desired results. The word EXCEPT is the last entry written in a minor section, and may be used to exclude up to ten of the locations defined. These exclusions are identified by their position in the sequence. If, in the example of figure 29, holes 3, 5, and 7 were to be excluded, the Statement would be written as follows:

```
DRILL, 1620/DAG, SX(-2.0) SY(-3.0) EX(1.0) EY(1.0) *
   NH(9) EXCEPT (3,5,7)/DP(1.15) $
```

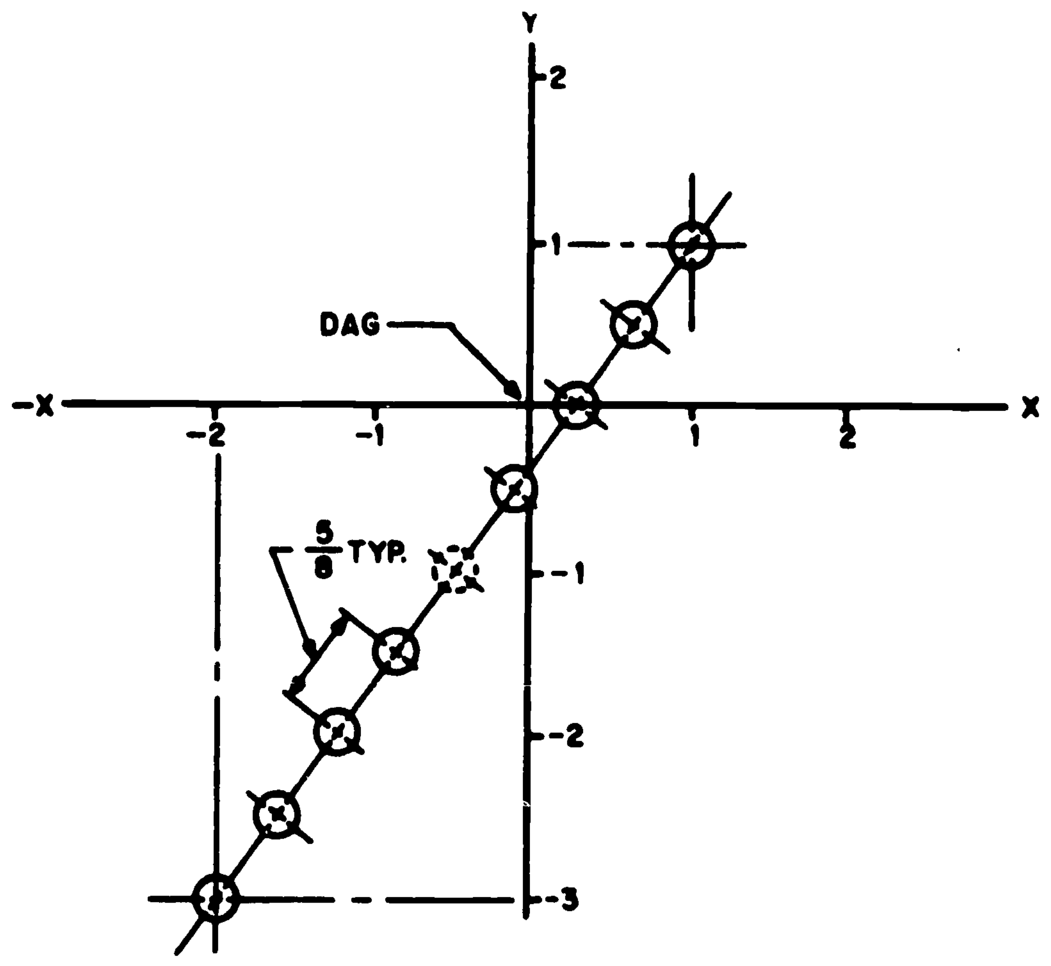


Figure 29.

In figure 24, (page 35) a bolt circle with twleve holes was illustrated. If the fourth, fifth, and sixth were not desired, the statement would have been written as follows:

```
DRILL, 0101/DAA,AT(1.5,1.5) R(1.25) SA(0.0) IA(30.0) *
    NH(12) EXCEPT(4,5,6)/DP(0.223) $
```

Note:

In Bolt Circles and Incremental Programming, the Number of Holes (NH) is a summation of all the locations, beginning with one at the first location, and including the exceptions. The Bolt Circle example above specifies NH(12) EXCEPT (4,5,6), resulting in nine drilled holes.

EXCEPT may be used only in the statement defining the routine. It may not be used to exclude the first point or after the statement has been defined as a pattern.

Section 9. AUTOSPOT II and the Pratt & Whitney Post Processor

This section contains the specific types of AUTOSPOT II statements required by the postprocessor program to punch the paper tape and to perform certain other error diagnostics not performed by the preprocessor program.

A. AUTOSPOT Language

1. Major Section

Operation descriptors must be given. A tool number (numerical) may be given and the program will generate a tool change stop, tape punches 2, 4, 8, each time a new one is encountered. When the stop occurs, the new tool number will appear on the printout. The first tool used will not generate this stop condition; however, its number will be printed out. If no tool number is given, every change in operation description will cause the new operation to be printed out. No stop conditions will be generated. Any other information in the major section will be ignored.

2. Minor Section

All two-dimensional coordinate information with the exception of STOP, GOTO, slopes, and arcs are handled by the post processor. Minor Section STOP's, GOTO's, slopes, and arcs are ignored.

3. Auxiliary Section

If both Depth (DP) and Feed Rate (FR) are given, they will be used in the tool travel computation and if Switch #2 is on they will be printed on the typewriter. The balance of the Auxiliary Section commands are ignored.

4. Special Commands

The REMARK command is printed out wherever it occurs in the source program. DASH, START and FINI commands are required, all others are ignored. The START command generates a sequence number and a rewind stop code ($). The FINI command generates the tool change code (tape punches 2, 4, 8), the automatic rewind code (/), and a sequence number on the tape.

B. The error message TABLE TRAVEL ERROR and a program stop will occur if either X or Y exceed the maximum table travel distance. Similarly, the message DASH ABSENT will occur if a required DASH is absent. The data in question will be bypassed and the balance of the program processed.

C. Tabs

The program will generate the required tabs if either successive X's or Y's or X's and Y's are equivalent. If an expected tab is missing, the particular information involved may have caused an unexpected rounding problem.

D. Tab Settings on the Typewriter

Two tabs are required and should be set at 35 and 65 or, 40, 60, 80 whichever gives the most suitable printout.

E. Supplementary Information

After a FINI command is processed the program prints FINI POST PROCESSOR and records the number of steps, tape reader time, tool travel distance and the tool travel time. The tool travel time is computed by the following equations:

$$T_i = T_{i-1} + \left[1.0 + \frac{\text{Max } \Delta X(\Delta Y)}{5} \right] /60 + \frac{DP}{FR} + \frac{DP}{120}$$

T_i, T_{i-1} = time (minutes)

$\Delta X = (X_i - X_{i-1})$

$\Delta Y = (Y_i - Y_{i-1})$

The program selects the larger of the two values (X or Y) for the time computation.

DP = Depth (inches)

FR = Feed Rate (ipm)

F. Machine Tool Input

This program converts AUTOSPOT statements into the type of instructions required by the Tape-O-Matic controller, with tape instructions in tab sequential format. The output tape, prepared by the 1620 DPS, may be used directly on the machine tool.

1. Machine Tool Dimensioning

The control system for this machine tool employs the absolute dimensioning system. The procedure to establish part to machine tool orientation is explained in detail under Section G (AUTOSPOT Statements, pages 43 thru 46).

2. Tool Changes

The program will generate a stop each time a new tool number is encountered in an AUTOSPOT machining statement.

G. AUTOSPOT Statements

This machine tool has a floating zero feature which can be located at any position within the X, Y control limits. Due to this feature DASHA and REMARK/TP statements are used to locate the part to the machine table, and to provide a table travel diagnostic. These and other pertinent statements are discussed in the following sections:

1. Definition Statements

a. DASHA: The statement DASHA will always be used to establish the "zero point" of the part from the "set up point" on the machine table. The coordinate values of the DASHA will then become the first block of information on the tape with the opposite algebraic sign. These values may be viewed as the coordinates of the machine set up point measured from the part zero point.

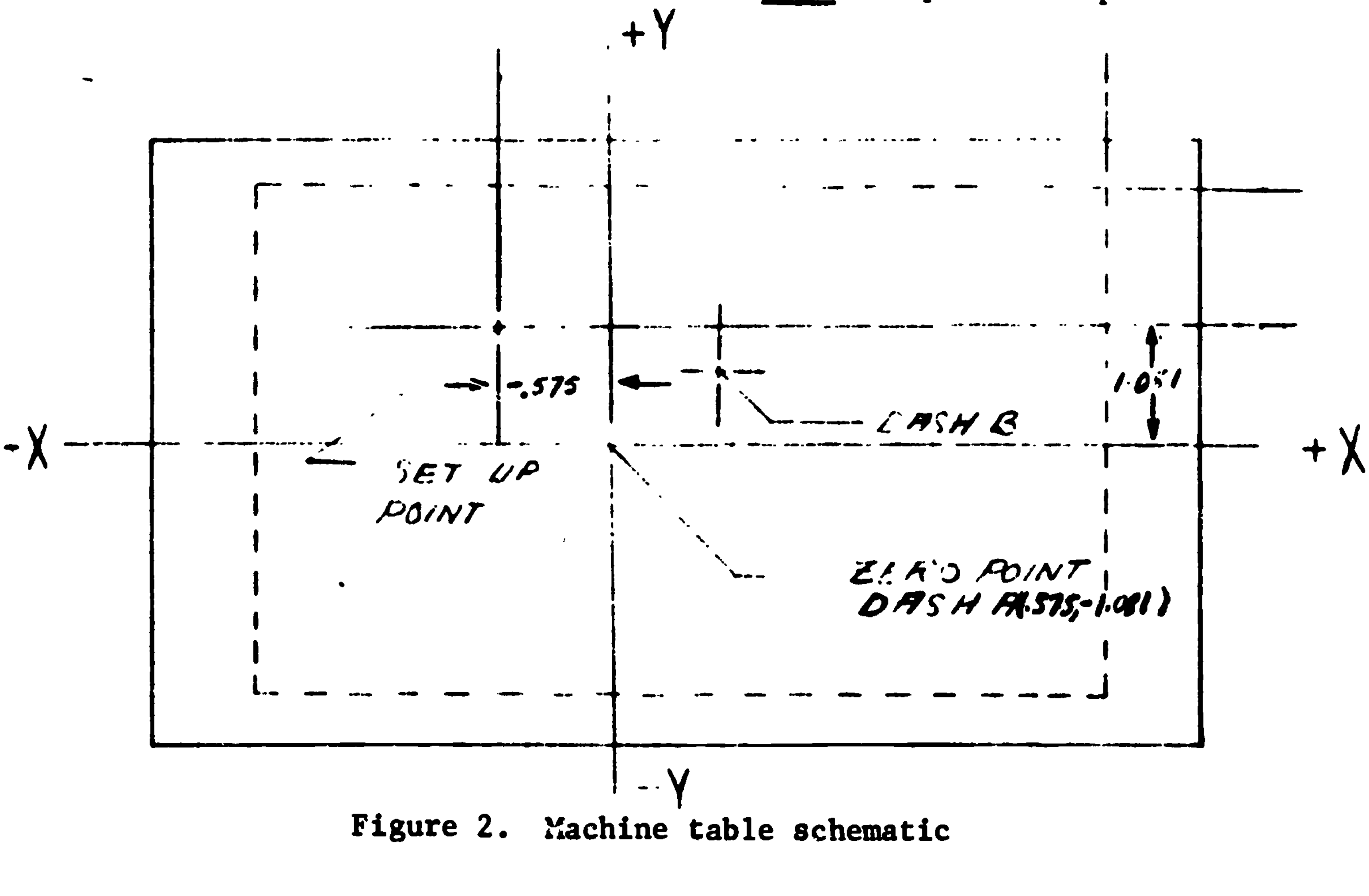


Figure 2. Machine table schematic

Example:

AUTOSPOT: DASHA (2.0, -3.5)$

Output: 000 TAB-02000 TAB+03500 EOB

Description: The origin of the Cartesian coordinate axes (EIA axes convention) is located at a predetermined set point on the machine table. The coordinate locations of the zero point on the part are then identified in the DASHA statement. All succeeding DASH's are referred to DASHA.

Example:

Definition Statement: DASH B = DASHA (2.0, 3.0)$

Machining Statement: DRILL, 201/DAB (2.0, 1.0)/*
DP (0.5)$

Output: 000 TAB + 04000 TAB + 04000 EOB

Description: Within the Definition Section, a DASH B location is referenced from DASHA (See Figure 2). A dilling operation is desired at the X, Y locations (2.0, 1.0) measured from DASHB. The program then outputs the adjusted coordinates as shown in the above example.

b. <u>REMARK/TP</u>: The REMARK/TP statement provides the program with specific information to perform a table travel diagnostic. The following example makes reference to Figure 2 (page).

Example:

REMARK/TP (12.000, 04.000)$

Description: The limits of the X and Y travel are measured from the set point as first quadrant coordinates. <u>Both X and Y coordinate values must be entered as a five digit number with the decimal point between the second and third digit</u>.

Note: Any REMARK/ statement that uses the alphabetic letters (TP) immediately following the /character (REMARK/TP) will cause a computer halt unless followed by the table travel diagnostic information.

2. <u>Tool information</u>

The tool information statement is <u>not</u> required by this program.

3. Machining Statements

a. Major Section: An operation name, e.g., DRILL, and a tool number are written as

DRILL, 301/ Minor Section/ Auxiliary Section$

Description: The program will generate a tool change stop command when a new tool number is encountered. No tool change command is generated if successive statements contain the same tool number.

All major section statements with the exception of STOP and GOTO are handled by the program. The program does not recognize these instructions, therefore, no computer halt nor tape, card or typewriter output is made.

b. Minor Section: All two dimensional coordinate (X,Y) information is handled by this program with the exception of STOP, GOTO, slopes and arcs.

c. Auxiliary Section: The machining depth (DP) and the feed rate (FR) are given in this section. Although the feed rate information is not required by the machine tool tape format, it is used to compute the actual machining time in Z. If the feed rate information is left out, an error message will be typed out by the post-processor.

Example:

20 DRILL,200/DAA (X_1, Y_1) (X_2, Y_2) /*
DP(1.0)FR(1.0)$

21 DRILL,200/DAA(X_3, Y_3) (Y_4, Y_4)/DP(1.0)$

22 DRILL,210/DAA(X_5, Y_5) (X_6, Y_6)/*

DP(1.0)FR(0.5)$

Description: The feed rate required for statement 21 is identical to that of statement 20 therefore, no (FR) entry is made. However, statement 22 requires a different feed rate due to a difference in drill size, etc. The program will use the feed rate given in the statement for all succeeding statements until it encounters a new one.

4. Special Statements

The START statement generates a sequence number and a rewind stop code (%).

The FINI statement generates a tool change code (&) and an automatic rewind code (/).

H. Post Processor Output

The following information does not appear on the output tape, but is typed on the listing if SWT #2 is on.

1. Heading

The heading printed by the typewriter is as follows:

AUTOSPOT - TAPE-O-MATIC POST PROCESSOR

PART NUMBER - NAME -

2. Output Statement Numbering

Each line of output information is numbered for identification purposes.

3. Estimated Production Time

Statements following the completion of the program are as follows:

FINI POST PROCESSOR

TOTAL PRODUCTION TIME XXX.X

The total production time is measured in minutes.

INTRODUCTION

Although most of the operations and terms contained in this Appendix are not used by the Pratt & Whitney Drilling machine, they have been left as an example of the full capabilities of AUTOSPOT II, as it might be used in other numerical control installations.

Section 10. Appendix A

A. Glossary of Symbols and Words

1. Definition Statements

a. DASH - DATUM, Surface or Hole; a dimension in terms of X, Y or X,Y and Z from the machine tool home to datum point of the part on the blueprint.

b. CL - Clearance; the minimum tool clearance from the part during positioning.

c. DH - Deep Hole: a drilling sequence expressed in tool diameters and limited to six terms.

d. DW - Dwell; A spindle rotation without positioning.

e. REMARK/ - Comments and pertinent information written by the programmer. Limited to 35 characters after the slash mark. Any number of REMARK statements may be programmed.

f. MANUAL - Tool position location for manual tool changes and inspection. Dimensioned from machine tool home and produces a spindle stop.

g. SAFE - A Tool position location during table rotation, and dimensioned from machine tool home.

h. TP - Table Position - The position or index of the table. Also used for Travel Parameter after REMARK/.

2. Tool Information Statements

Tool information is written in a fixed format and is defined in the order used on the form. Tool information not required may be omitted.

a. Statement Number - Number of the statement as it appears in the program, written in columns 1 to 5.

b. TOOL/ - Required with all tool information input and written in columns 6 to 10.

c. Operation - The type of operation in which the tool is to be used, written in columns 11 to 16. Milling cutters used in more than one type of operation should be identified only once, and as a MILL.

d. Number - The number of the cutting tool or tool holder, and written in columns 17 to 20.

e. Manual - The letter M is written in column 21 when a tool is to be manually changed on machine tools capable of automatic tool changes. This also requires that a manual location be identified in the Definition Section.

f. Diameter - The over-all diameter of the cutting tool is written in columns 22 to 28.

g. Tip Angle - The included angle of the tip of the cutting tool, expressed in degrees, tenths, and hundreds is written in columns 29 and 34.

h. Setting Distance - The over-all length of the tool, measured on the machine and expressed in inches, tenths, hundreds, and thousands (as required), is written in columns 35 to 41.

i. Effective length - The cylindrical length of the tool, measured on the machine and expressed in inches, tenths, hundreds, and thousands (as required), is written in columns 42 to 48.

j. Spindle Speed - The cutting tool spindle speed expressed in revolutions per minute or a machine tool code is written in columns 49 to 52.

k. CCW - The direction of rotation of the cutting tool is indicated in column 53. If the direction is clockwise, no entry is required. The letter L (Left-hand cutter) is written when the rotation is counterclockwise.

l. Feed Rate - The rate of cutting tool feed during machining is written in columns 54 to 59 and is expressed in inches per minute or a machine tool code. A decimal point is required, and may be written in any column.

m. Coolant - The coolant codes required by the particular machine tool is written in columns 60 to 62.

3. <u>Machining Statements</u>

a. Symbol Address

A maximum of five alphameric symbols (letters or numbers) may be used.

Section 10. Appendix A -- (continued)

b. Major Section

1. START - First line of the Machining Section
2. DRILL - Specifies a drilling operation
3. SPDRL - Specifies a spot drilling operation
4. CSK - Specifies a countersink operation
5. SPMIL - Specifies a spot mill operation
6. BORE - Specifies a bore operation where the spindle stops when the depth is reached
7. BOREOS - Specifies a bore operation without a spindle stop
8. CBORE - Specifies a counterbore operation
9. REAM - Specifies a ream operation
10. TAP - Specifies a tapping operation
11. PUNCH - Specifies a punching operation
12. OTHER - Provision for an undefined operation (Dummy Tool)
13. MILL - Specifies a milling operation
14. PMILL - Specifies a pocket milling operation
15. FMILL - Specifies a face milling operation
16. FLF - Facemill to the right of the left boundary
17. FRT - Facemill to the left of the right boundary
18. FUP - Facemill below the upper boundary
19. FDWN - Facemill above the lower boundary
20. MANUAL - Tool positioning to manual location
21. SAFE - Tool position to safe location
22. ONKUL - Turn coolant on
23. OFKUL - Turn coolant off

Section 10. Appendix A -- (continued)

24. GO TO - Tool positioning instruction

25. 0101 - Calls out a cutting tool number

26. TLRT - Positions tool to right of path direction

27. TLLF - Positions tool to left of path direction

28. (0.020) - Finish cut amount of material to be left for a second path operation

29. (R, 0.020) - Finish cut amount of material to be left for a second path operation

30. FINI - Last line of the program

c. Minor Section

1. DAA - Datum, Surface or Hole

2. X - Coordinate value in x

3. Y - Coordinate value in y

4. Z - Coordinate value in z

5. AT - Indicates an angle or location

6. GO TO - Position to a coordinate point, no machining

7. STOP - Position to a location and stop operation

8. RTO - Move right to a point

9. LTO - Move left to a point

10. UTO - Move up to a point

11. DTO - Move down to a point

12. STO - Slope cut to a point

13. CW - Clockwise path movement

14. CCW - Counterclockwise path movement

15. ARC - Type of cutting path

16. R - Radius

Section 10. Appendix A -- (continued)

17. SA - Starting angle for a bolt circle

18. IA - Constant angular change

19. NH - Number of holes to be operated upon

20. SX - First location of x in an operation series

21. SY - First location of y in an operation series

22. EX - Last location of x in an operation series

23. EY - Last location of y in an operation series

24. EXCEPT - Incremental exclusions

25. PAT 1 - Example of reference to a previously defined series of locations

26. REV - Perform the previously defined operation in the reverse order

27. INVR - Pattern inversion to the right

28. INVL - Pattern inversion to the left

29. INVU - Pattern inversion up

30. INVD - Pattern inversion down

31. THEN - Connects two Minor Sections

32. A - Angle used in polar notation

d. Auxiliary Section

1. DP ( ) Depth of cut

2. DI ( ) Diameter of spot drill or countersink

3. SS ( ) Spindle speed in RPM

4. FR ( ) Feed rate in IPM

5. DH - Deep hole drilling

6. DW - Tool dwell at depth

7. ONKUL - Turn coolant on

8. OFKUL - Turn coolant off

Section 10. Appendix B

AUTOSPOT - Phase 1 - Miscellaneous Information

1. When there is a "continue" card situation, designated by an asterisk (*) after last field, SCAN automatically reads in the next card.

2. Maximum number of DASH statements allowed is ten.

3. Maximum number of patterns, with regard to Phase 1 storage, is 20.

4. Approximately 90% of the "errors of form" are caught by the preprocessor.

5. When REMARK cards are encountered, the word REMARK/ is removed and the balance of the card is outputted.

6. START card resets the pattern name table to zero.

7. When an error is found in a pattern defining statement, the pattern name is removed from the pattern table. Also all associated minor section points which have been saved up to the error are lost.

8. Polar and Cartesian coordinates should not be used in the same minor section.

9. Bolt circle, incremental, and pattern incremental minor sections are considered to have a fixed format. Therefore the order of parameters given in the AUTOSPOT General Processor Manual must be followed. The maximum number of holes allowed is 33.

10. Maximum number of elements in an EXCEPT phrase is 10.

11. A total maximum of 25 X, Y, or Z's may be used in any one minor section. That is, the total number of X, Y, or Z's which can occur in a minor section is 25. If more are required, divide the minor section into two or more parts by use of THEN's.

12. The program is set up so that if floating point overflow or underflow occur the results will be either all 9's or all 0's respectively.

13. The program has set into it a "noisey mode" factor of 5.

14. REMARK and TOOL statements are outputted on a single card and this card has no sequence number. These cards may be out of sequence although this is not detrimental.

Section 10. Appendix B -- (continued)

15. REMARK statements are limited to 35 characters after the slash (/). If more characters are present, they will be deleted.

16. A tool number may be at most four integers or two alpha characters or one alpha character and an integer.

17. All first level patterns must be defined on the same surface.

18. All programs have been written in SPS-1.

19. The first hole in a routine may <u>not</u> be excepted.

<u>AUTOSPOT - Phase 2 - Miscellaneous Information</u>

1. Phase 2 of the Pre-Processor accepts coded output of Phase I.

2. Patterns are stored sequentially in the pattern table starting in core location (14508) and extending through location (19500).

3. Major section record types of pattern define operations are reduced to the next even integer.

4. All patterns must be homogeneous in structure.

5. Individual patterns are limited to 92 coordinate points.

6. Code (99) will cause the following message to be printed.

   END PHASE TWO

7. An illegal code (E1) will stop the program.

   Push start to continue.

8. In the event that patterns exceed allowable storage (E3) the program will terminate.

   Push start to reinitialize program.

9. An illegal tool number (E2) will stop the program.

   Push start to continue.

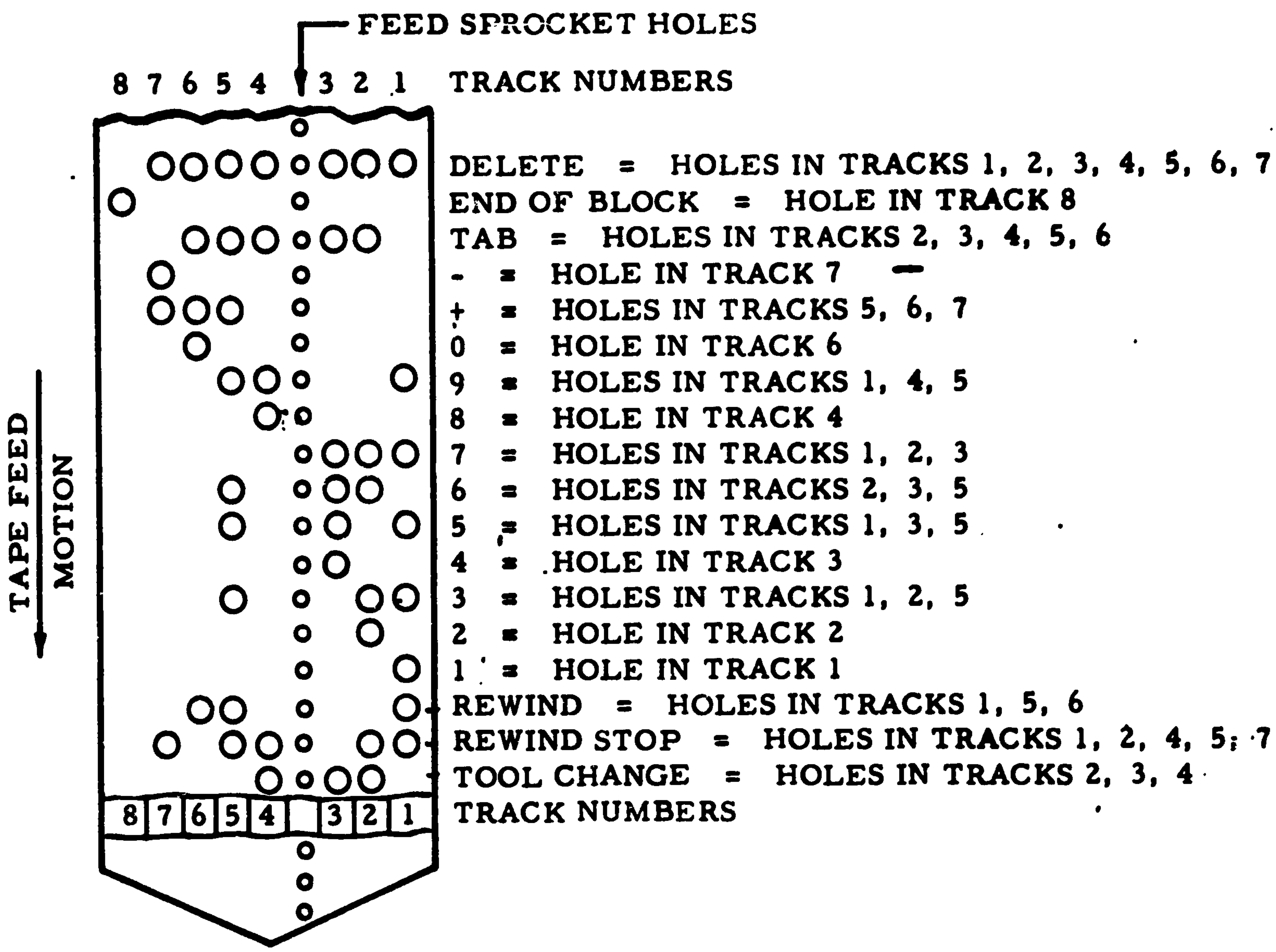
10. In the event that an individual pattern (E4) is too long the program will terminate.

   Push start to reinitialize program.

Section 10, Appendix C

Pratt & Whitney TAPE-O-MATIC Numeric Drilling Machine Paper Tape Codes

Tape used in the TAPE-O-MATIC Numeric Drilling Machine is standard one-inch wide, eight track tape (E.I.A. RS-244).



(Above figure taken from Pratt & Whitney Publication No. M3042-A4)

Note:

Usually characters in a code are all odd or even (this code is all odd). An extra "parity bit" is added (in track 5) where necessary to make this the case.

Section 10. Appendix D
The IBM Card

The IBM card measures 7-3/8 inches by 3-1/4 inches and is .007 inches in thickness. The card stock is of controlled quality, manufactured according to rigorous specifications in order to provide strength and long life. This is necessary to ensure the accuracy of results, the proper operation of IBM data processing machines, and the continued usability of information long after it is recorded.

The card is divided into 80 vertical areas called "columns" or "card columns." They are numbered 1 to 80 from the left side of the card to the right. Each column is then divided horizontally into 12 punching positions. Thus the IBM card has 960 punching positions in all. The punching positions are designated, from top to bottom of the card, 12, 11 or X, 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. The punching positions for digits 0 to 9 correspond to the numbers printed on the card. The top of the card is known as the "12 edge" and the bottom as the "9 edge." These designations are made because cards are fed through machines either "9 edge first" or "12 edge first." "Face up" means the printed side is facing up; "face down," the reverse.

Each column of the card is able to accommodate a digit, a letter, or a special character. Thus the card may contain up to 80 individual pieces of information. Digits are recorded by holes punched in the digit punching area of the card from 0 to 9. For example, the card in Figure 68 shows a 1 punched in column 63, a 9 in column 72, and a 4 in column 77.

The top three punching positions of the card (12, 11 or X, and 0) are known as the zone punching area of the card. (It should be noted that the 0 punch may be either a zone punch or a digit punch.) In order to accommodate any of the 26 letters in one column, a combination of a zone punch and a digit punch is used. The various combinations of punches which represent the alphabet are based upon a logical structure or code.

The first nine letters of the alphabet, A to I, are coded by the combination of a 12 punch and digit punches 1 to 9. Letters J through R are coded by an 11 or X punch and digit punches 1 through 9. S through Z, the last eight letters, are the combination of the 0 zone punch and digit punches 2 through 9. Figure 69 illustrates alphabetic coding. The conversion of letters to and from this coding structure is done automatically by the various machines used to record or process data and it is rarely necessary to refer to data in its coded form. The eleven special characters, which are considered alphameric data, are recorded by one, two, or three punches.

Figures 68 and 69 illustrate the two most common types of corner cuts -- upper left and upper right. The corner cut is used to identify visually a card type or to ensure that all of the cards in a group are facing the same direction and are right side up. Card types may also be distinguished by the use of colored cards or by a colored stripe on cards of a similar nature.

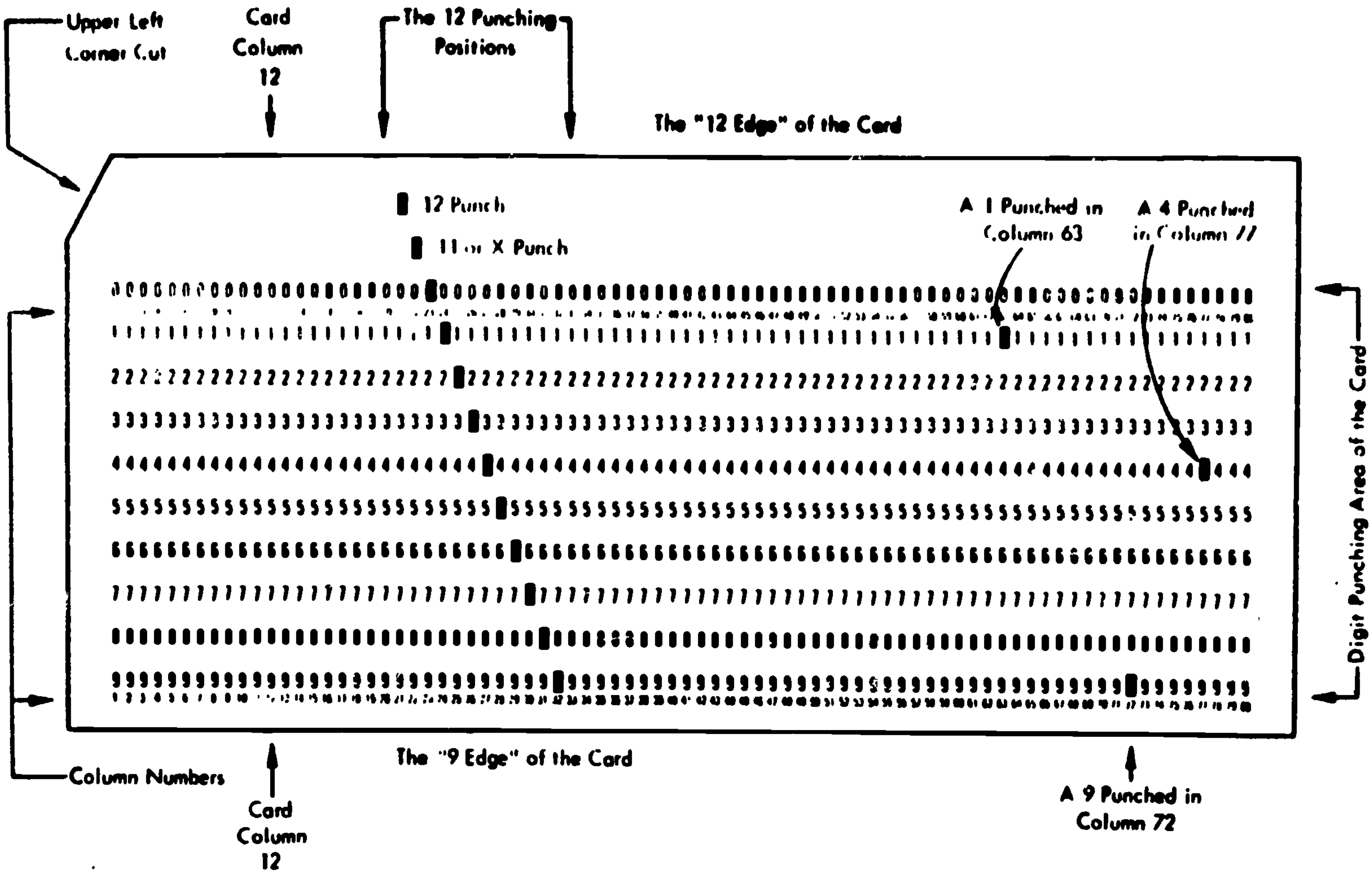


Figure 68. IBM Card

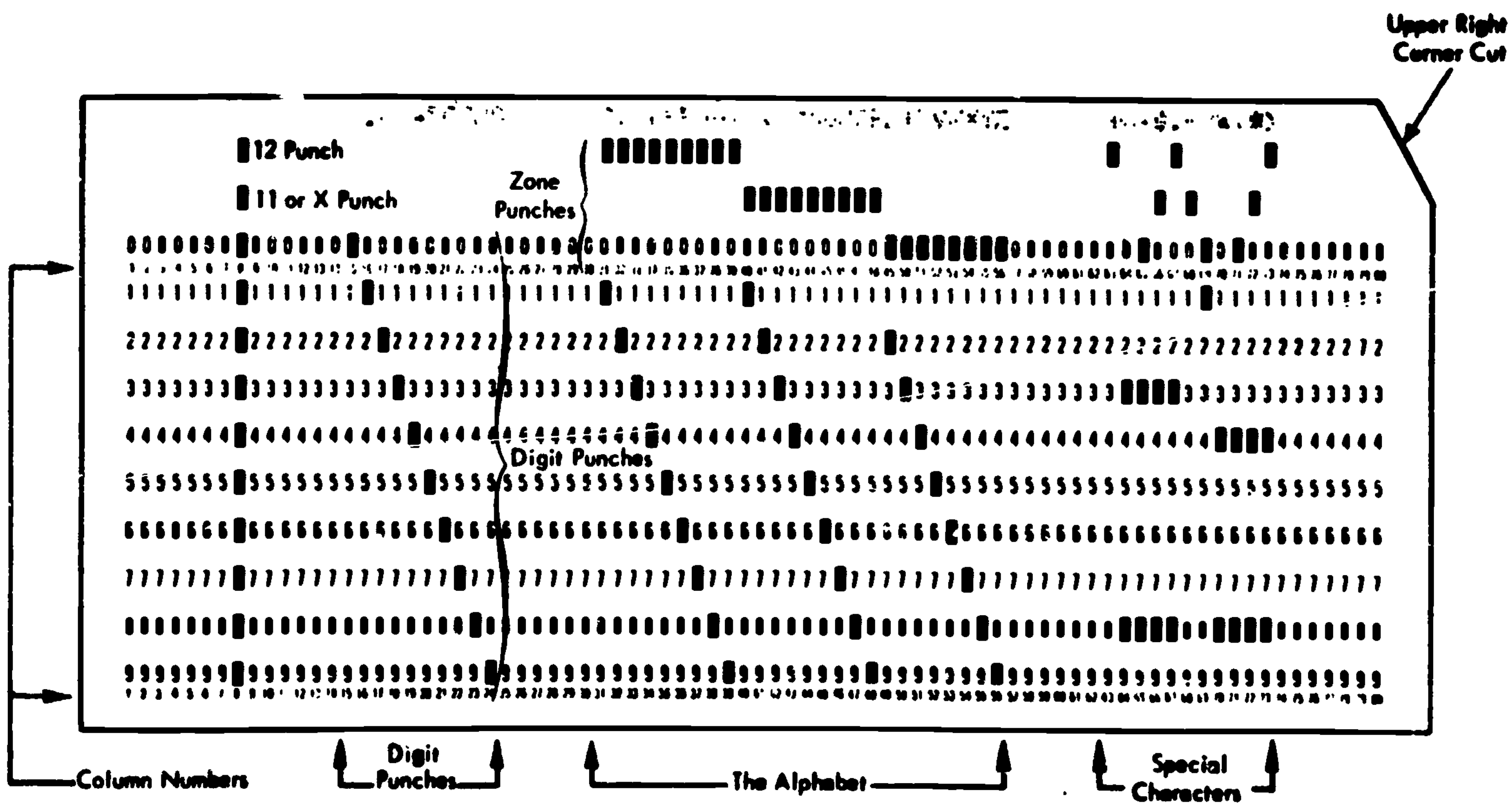


Figure 69. Card Character Coding

Field Definition

The fields in a card normally consist of 1 to 80 columns of data, depending on the length of a particular type of information. However, a field in 1620 core storage must consist of at least 2 digits or positions.

Numerical Data Field Definition

The high-order column of a field is punched with an 11 punch as well as the digit punch. Thus, the field defining column of a numeric field contains an alphameric character (J through R) which becomes a digit with a flag when read into core storage by a Read Numerically instruction. (See CHARACTER CODING, Appendix D.)

Section 10. Appendix E
1621 Paper Tape

Paper Tape and Paper Tape Code

Data is punched and read as holes in a one-inch-wide chad paper tape (in chad paper tape the holes are completely punched out), at a density of ten characters to the inch. An eight-track paper tape code is used. Seven positions, or tracks, across the width of the tape are used for coding numeric, alphabetic, and special characters. One track is used for EL (end-of-line) characters. Figure 70, representing a section of paper tape, illustrates the eight tracks and all coded characters.

The lower four tracks of the tape (excluding the feed holes) are used to record numeric characters in the BCD mode. For example, a hole in track 1 represents a numeric 2; a combination of 1 and 2 punches represents a numeric 3; and so on.

The X and O tracks are used in combination with the numeric tracks to record alphabetic and special characters in a manner similar to zone punches in IBM cards. A Read Numerically instruction causes a single X punch to read into core storage as a flag bit (negative zero).

The check track is used to establish correct parity. As a check that every character is recorded correctly, each column of the tape is punched with an odd number of holes. The EL track is not considered in the parity check.

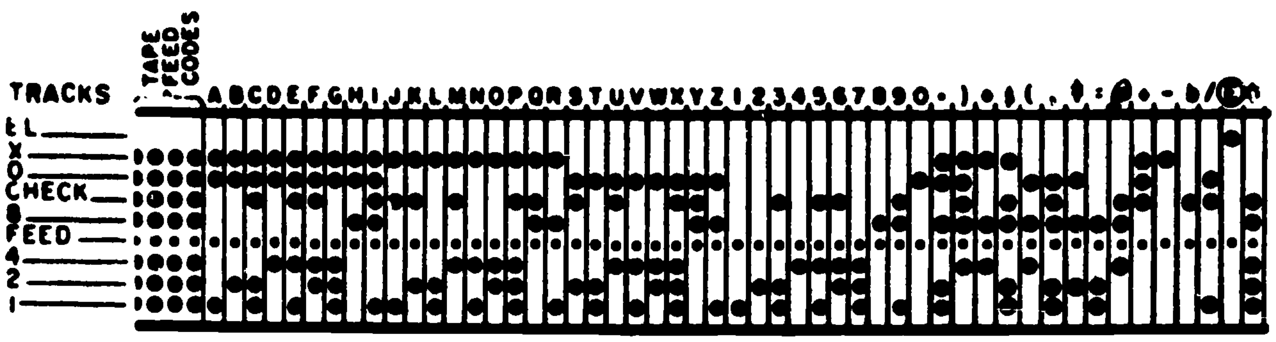


Figure 70. Paper Tape Codes

Tape Specifications

The 1621 Paper Tape Unit is designed to operate with IBM paper tape, P/N 304469 (Figure 71). Other paper tape of equivalent paper stock may be used, but it must conform to Electronic Industries Association specifications, RS-227.

The specifications for dimensions of punched tape can be determined after conditioning the tape to the following requirements for 24 hours:

$$75^{o}F \pm 3.5^{o}$$
$$50\% \ RH \pm 2\%$$

Tape Splicing

Paper tape handling and processing will occasionally require tape splicing when paper tape needs to be altered in length, edited, or repaired. If possible, a splice should be made in nondata portions of the tape. The ability of the paper tape reader to successfully and reliably read spliced tape depends upon the quality of the splice. The following is a procedure for manually splicing two lengths of paper tape together:

1. Punch tape feed codes into the two ends of the tape to be spliced together.
2. Cut the tapes at approximately a 45^{o} angle.
3. Holding the ends of the tape with the tape feed holes, overlap the tape end in the left hand over the tape end in the right hand approximately 1/16 inch.
4. Glue in this position with holes aligned, using a quick-setting glue such as IBM tape mucilage, P/N 221030.

Other methods of tape splicing require the use of special tape splicing equipment.

The use of tape splicing equipment should be considered if it becomes necessary to repeatedly edit tape or alter the length of tape. Special splicing equipment and materials will provide efficient, accurate, and more

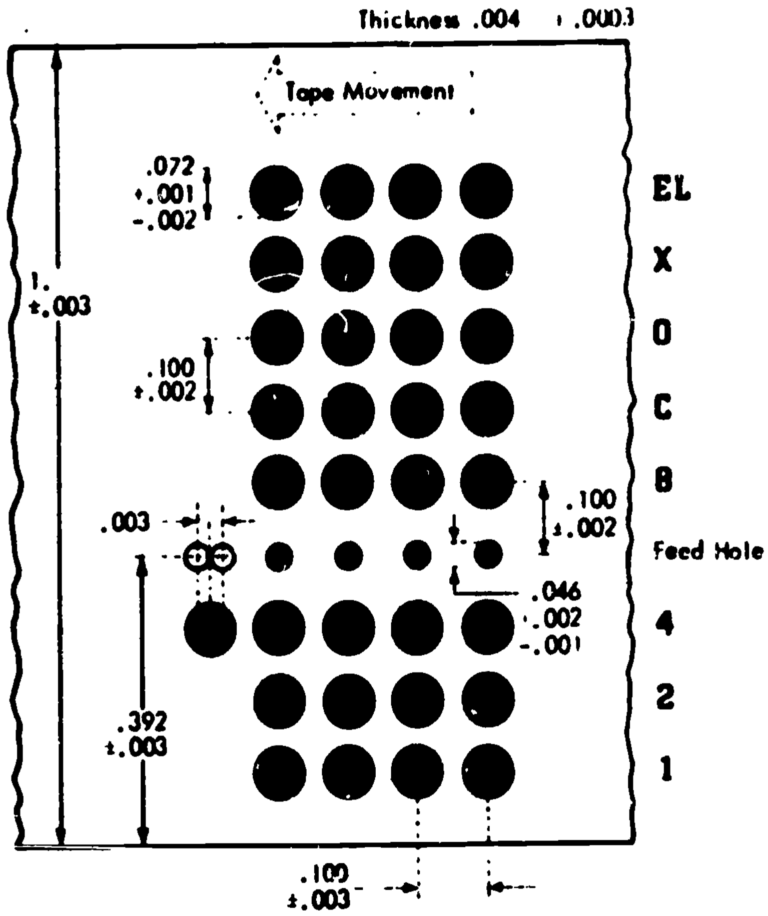


Figure 71. Paper Tape Specifications

permanent tape splices. The selection of appropriate splicing equipment, from the many types now being offered by various manufacturers depends upon the quality of the splice desired, life expectancy of the splice, time allotted to make the splice, and a price justification. The best splicing results will be obtained by first analyzing paper tape splicing needs and then purchasing the tape splicer and splicing materials best suited to these needs.

Whatever the splicing method used, the finished splice should satisfy the following conditions:

(a) Total thickness of the spliced tape area must be less than 0.010 inch.
(b) The splice must be approximately as strong as IBM paper tape.
(c) The splice width must match the width of the tape itself.
(d) The splice must be flexible.
(e) The splice must not create a gum or hindrance in the tape feed area.

Types of Tape Splices

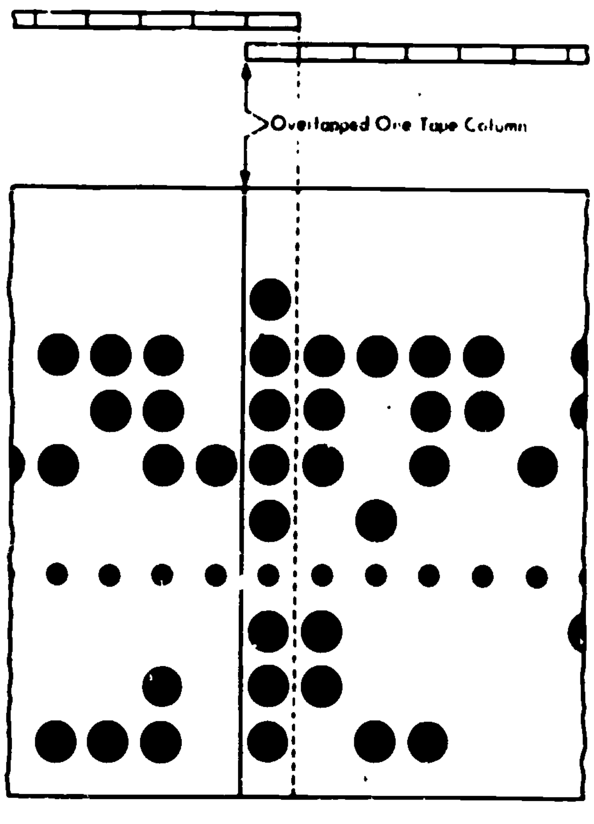
There are two types of splices: overlap splice and butt-joint splice.

Overlap Splice

The overlap splice consists of two matching paper tape ends overlapped by at least one tape column and held together with an adhesive.

With some splicing equipment, the pieces are welded together through a process of heat, pressure, and a liquid bonding agent. With this type of equipment, alignment accuracy of the tape is not required of the splice equipment operator, and the tape splicing rate is approximately one per minute.

With other overlap-type splice equipment, the tapes are glued together with a quick drying adhesive. In this process, some alignment accuracy of the tapes is required of the splice equipment operator. Tape splicing rate is about three to five minutes per splice.



Advantages of Overlap Splicing

1. A large variety of overlap splicing equipment is commercially available.
2. Many splicers are available at a low investment cost.
3. Quality of splice is not usually dependent upon the operator's skill.

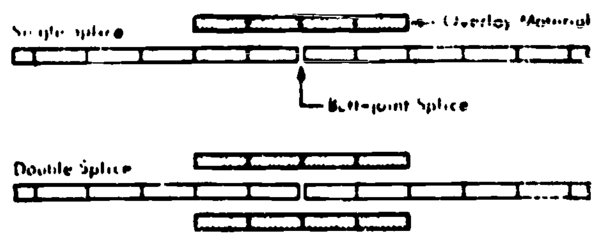
Disadvantages of Overlap Splicing

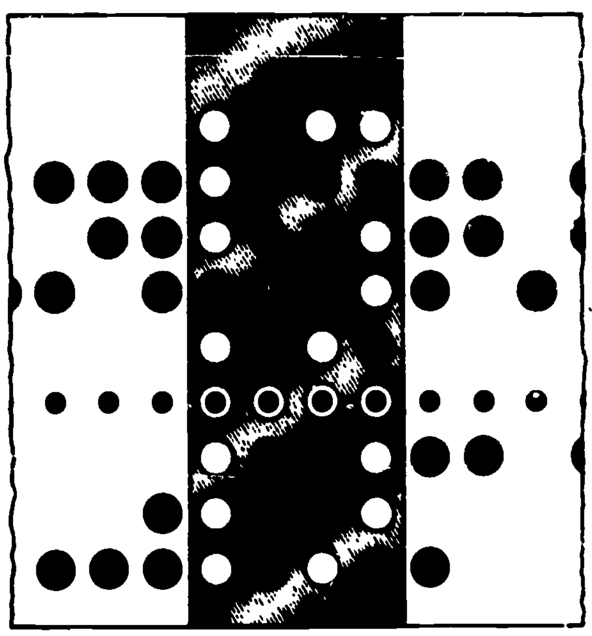
1. An overlap-type of splice is not suitable within the tape data area because overlapped columns will result in lost data, parity errors, and/or invalid codes.

2. Low production on some splicing equipment, due to the lengthy time required for the glue to dry.
3. Short life of splice.

Butt-Joint Splice

The butt-joint splice consists of two symmetrically matched paper tape ends, butted together and held in position by a bonding agent and an overlay material. The overlay material can be plastic or paper, and can be placed on one or both sides of the tape.





With some splicing equipment, the overlay material is heat sensitive and is bonded to the tape through the use of a heated iron. Alignment accuracy of the tapes is not required of the tape splicing operator. Tape splic'ng rate is approximately one per minute.

With other butt-joint splicing equipment, the paper is bonded to the overlay material by an adhesive on the overlay material. Alignment accuracy of the tapes depends upon the skill of the splice equipment operator. Tape splicing rate is approximately one per minute.

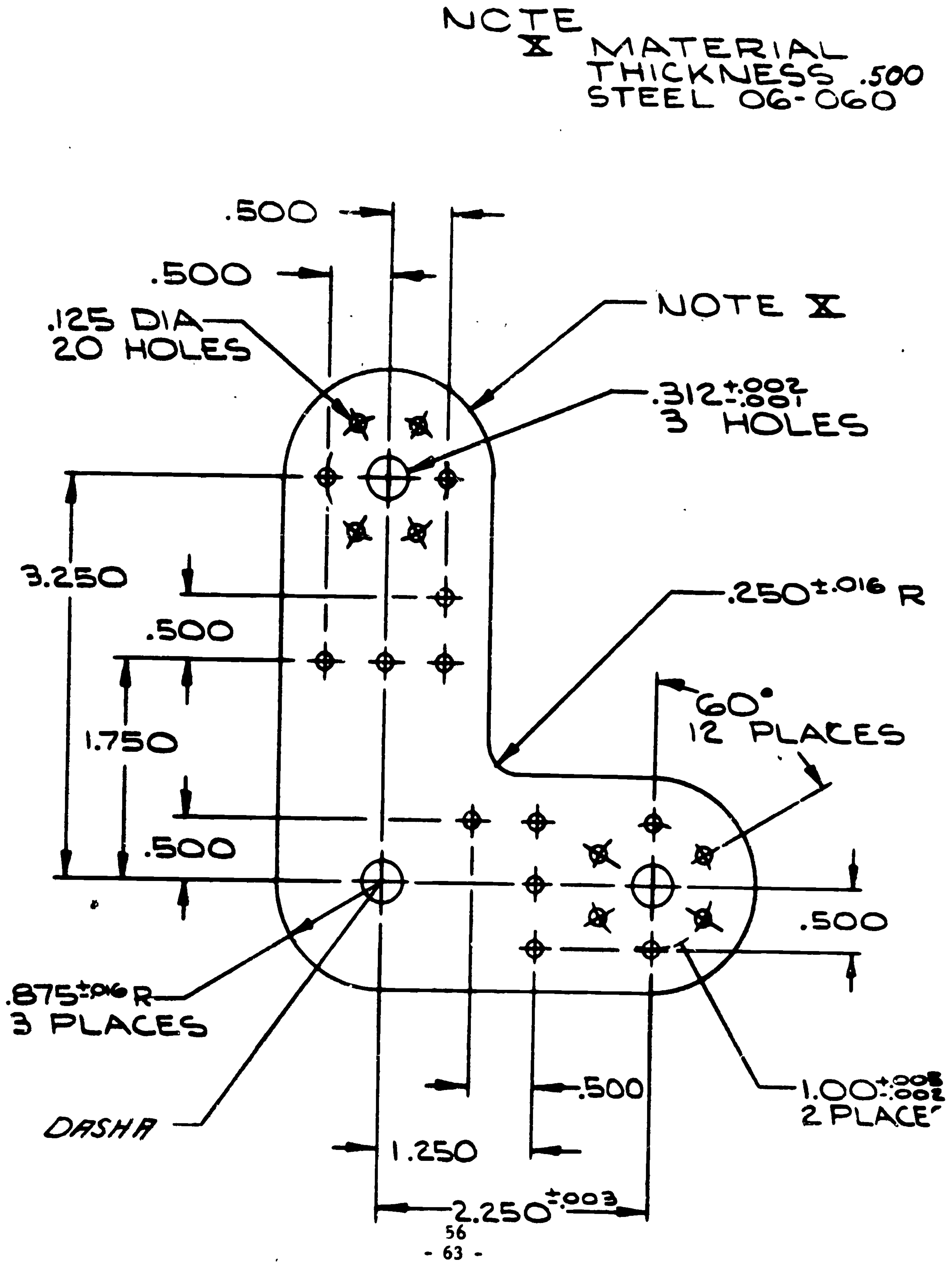
Advantages of Butt-Joint Splice

1. The splice can be made in a data-portion of tape without losing or altering data.
2. This type of splice permits tape repairing due to tears or damage.
3. A thinner splice -- the total thickness of the tape and splice (with a plastic overlay) is usually thinner than two thicknesses of paper tape.

Disadvantages of Butt-Joint Splice

1. The quality and accuracy of each splice may depend upon the skill of the splice equipment operator.
2. There is a limited variety of accurate butt-joint splicing equipment.

SAMI LE PART



NOTE
X MATERIAL
THICKNESS .500
STEEL 06-060
.500
.500
.125 DIA
20 HOLES
NOTE X
.312 +.002 -.001
3 HOLES
3.250
.500
.250 ±.016 R
60°
12 PLACES
1.750
.500
.500
.875 ±.016 R
3 PLACES
.500
1.00 +.003 -.002
2 PLACES
DASHA
1.250
2.250 ±.003

```
REMARK/TAPE-O-MATIC-SAMPLE PROGRAM$
REMARK/TP(13.ØØØ,7.5ØØ)$
DASHA(3.Ø,Ø.Ø)$
START$
PAT1=DRILL,125/DAA,AT(Ø.Ø,3.25)R(Ø.5)SA(Ø.Ø)IA(6Ø.Ø)NH(6)/DP(Ø.5)FR(5.Ø)$
PAT2=DRILL,125/DAA(Ø.5,2.25)(Ø.5,1.75)(Ø.Ø,1.75)(-Ø.5,1.75)/DP(Ø.5)$
DRILL,125/PAT2(Ø.75,Ø.5)AT(9Ø.Ø)THEN,PAT1(2.25,ØØ.ØØ)AT(21Ø.Ø)/DP(Ø.5)$
PAT3=DRILL,3Ø2/DAA(2.25,Ø.Ø)(Ø.Ø,Ø.Ø)(Ø.Ø,3.25)/DP(Ø.5)$
BORE,3125/REV,PAT3/DP(Ø.5)$
FINI$
```

```
AUTOSPOT II PREPROCESSOR
END PREPROCESSOR
SPECIFICATION SECTION

MACHINE SECTION
END PHASE 1
PHASE2 SECTION
END PHASE2

AUTOSPOT-TAPE-O-MATIC POST PROCESSOR

PART NUMBER-       ,NAME
TAPE-O-MATIC-SAMPLE PROGRAM$
TP(13.000,7.500)$
001X-03000X-00000        SET POINT                    0001
$002                     START                        0002
                         FEED RATE 05.0 IN/MIN
                          DRILL CHANGE TOOL,TOOL NO. 0125
004X+00500X+03250        DEPTH 0.5000                 0004
005X+00250X+03683                                     0005
006X-00250                                            0006
007X-00500X+03250                                     0007
008X-00250X+02816                                     0008
009X+00250                                            0009
010X+00500X+02250        DEPTH 0.5000                 0010
011X       X+01750                                    0011
012X-00000                                            0012
013X-00500                                            0013
014X+00750X+00500                                     0014
015X+01250                                            0015
016X       X-00000                                    0016
017X       X-00500                                    0017
018X+01816X-00250        DEPTH 0.5000                 0018
019X+02250X-00500                                     0019
020X+02683X-00250                                     0020
021X       X+00250                                    0021
022X+02250X+00500                                     0022
023X+01816X+00250                                     0023
X024                      DRILL CHANGE TOOL,TOOL NO. 0302
025X+02250X+00000        DEPTH 0.5000                 0025
026X-00000                                            0026
027X       X+03250                                    0027
X028                       BORE CHANGE TOOL,TOOL NO. 3125
029                      DEPTH 0.5000                 0029
030X       X+00000                                    0030
031X+02250                                            0031
X/032                    STOP                         0032
FINI POST PROCESSOR

 TOTAL PRODUCTION TIME 003.3
```

COGO

1967 SUMMER INSTITUTE
MIAMI-DADE JUNIOR COLLEGE
COGO

Exercise 1

Write a COGO program using Sketch 21 to determine the following:

1. Find the coordinates, relative to the origin, of the centers of the arcs and circles,
2. Plot the centers found in '1'.

Exercise 2

Write a COGO program using the COGO Sketch to determine the following:

1. The distance from the nose of the median to the intersection of the center lines of Road A and Street 1,
2. The distance and offset measured along and from the center line of Road A of the PC, PRC and PT of the median,
3. The center coordinates of the reverse curve and the area of the median from the nose to the PT,
4. The coordinates of:
   A. PC and PT of all R/W arcs,
   B. The center of all R/W arcs.

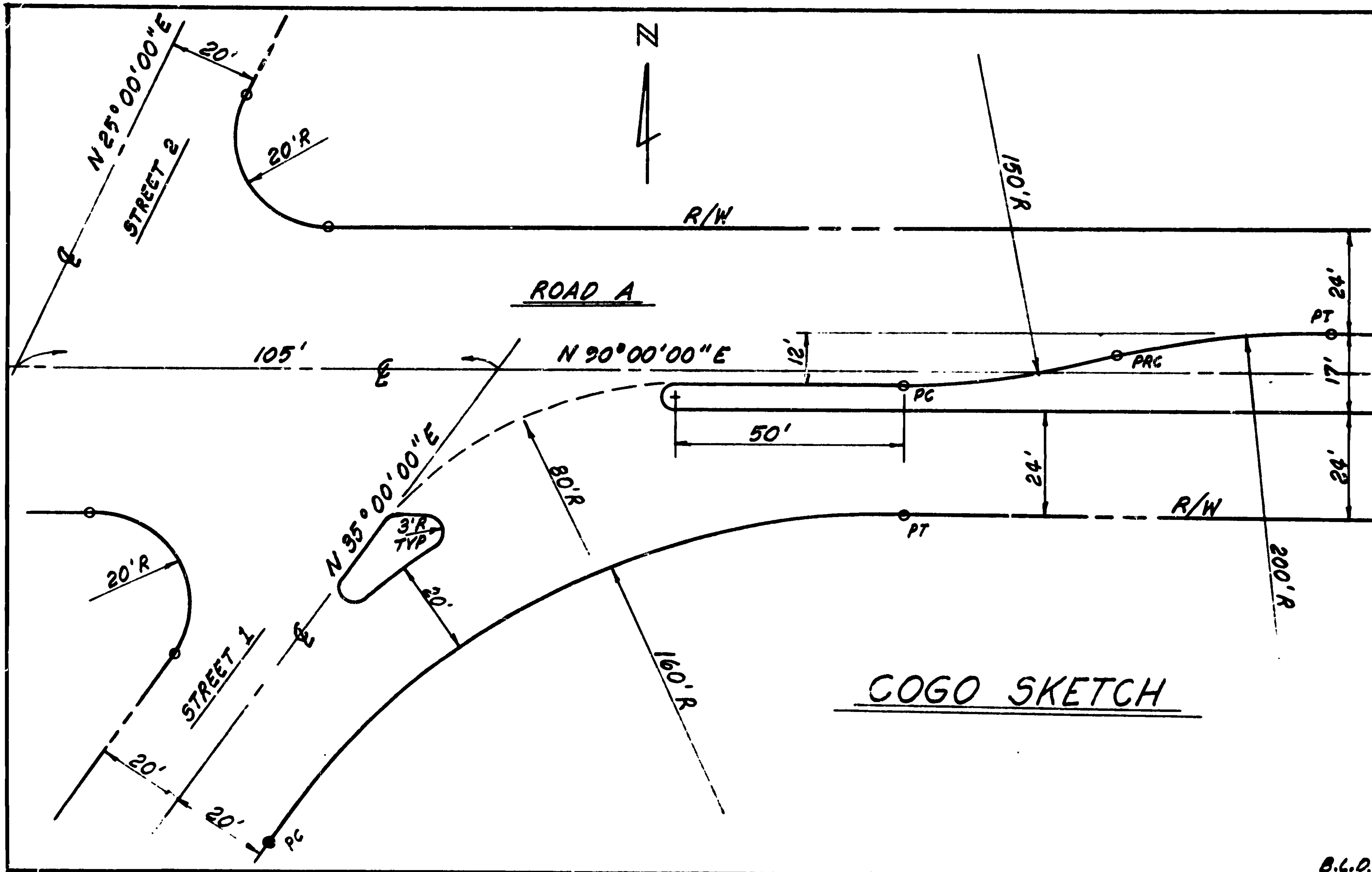
Exercise 3

Write a COGO program using the COGO Sketch and any data from Exercise 2 to determine the following:

1. The distance from the NW corner of the traffic island in Street 1 to the intersection of the center lines of Street 1 and Road A,
2. Center coordinates of the arc of the traffic island,
3. The tangent and deflection angle of the curve that forms the S. R/N line of Road A,
4. Assume the P.C. of the median is at Station 9 + 00.00; find the Station at the PRC and PT of the median.

Exercise 4

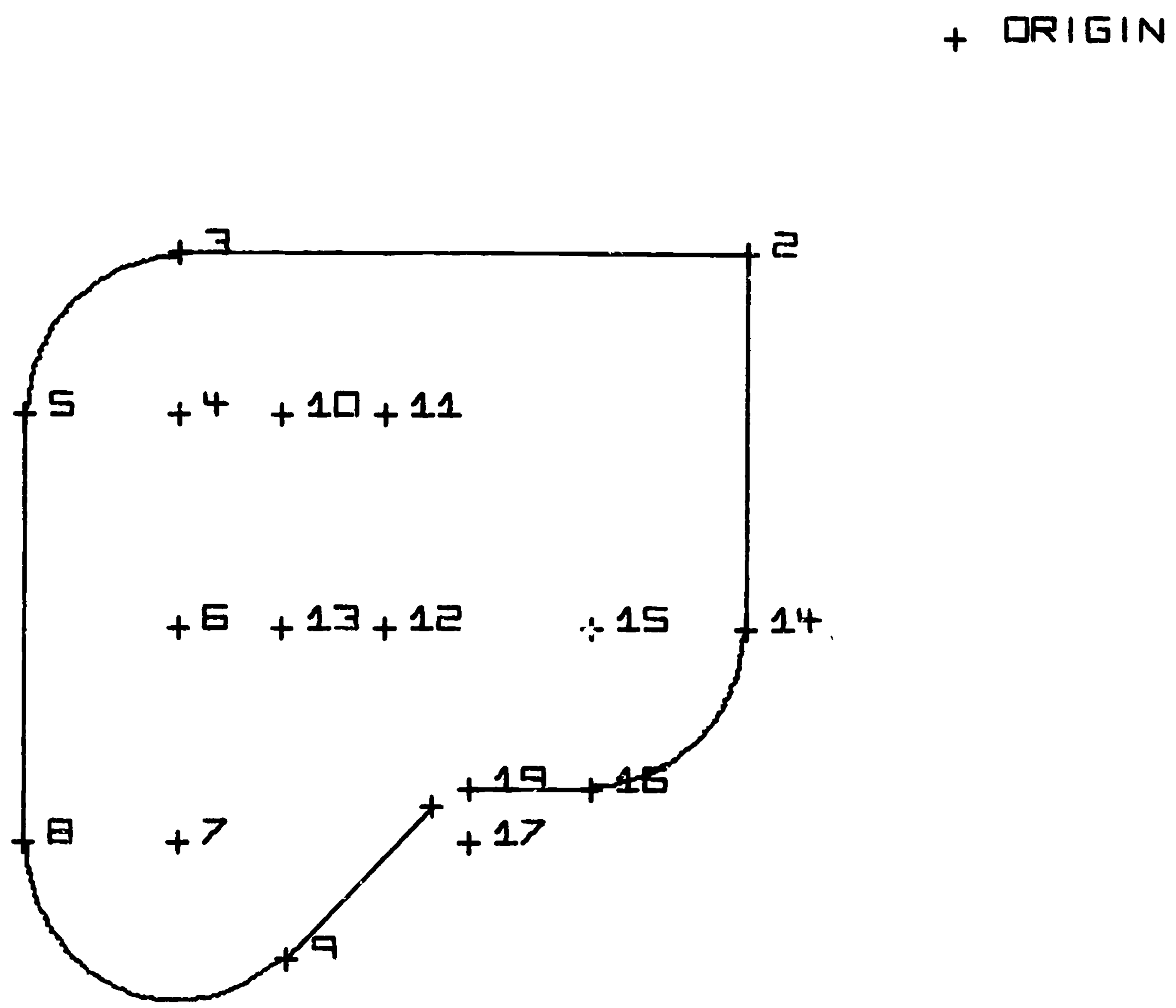
Write a COGO program to plot the COGO sketch.



COGO SKETCH
ROAD A
STREET 1
STREET 2
N
N 90°00'00"E
N 35°00'00"E
N 25°00'00"E
105'
R/W
R/W
150'R
200'R
160'R
80'R
20'R
20'R
3'R TYP
50'
12'
17'
24'
24'
24'
20'
20'
20'
20'
PC
PT
PRC
PT
PC
B.L.D.

1 9 6 7 S U M M E R I N S T I T U T E
COGO EXERCISE 1

```
CLEAR              1     99
STORE              2 7. 5.5
                   1 8. 6.5
                   85 2. 2.
                   86 8. 6.75
LOCATE/AZI         2  3  2.75  270  00  00.
                   3  4  .75  180  00  00.
                   4  5  .75  270  00  00.
                   4  6  1.  180  00  00.
                   6  7  1.  180  00  00.
                   7  8  .75  270  00  00.
                   7 9 .75 135 00 00.
                   4 10 .5 90 00 00.
                   10  11  .5  90  00  00.
                   11  12  1.  180  00  00.
                   12  13  .5  270  00  00.
                   2  14  1.75  180  00  00.
                   14  15  .75  270  00  00.
                   15  16  .75  180  00  00.
                   9  30  1.  45  00  00.
                   16  31  1.  270  00  00.
PARALLEL/LINE      9  30  .25  32  33
PARALLEL/LINE      16  31  -.25  34  35
POINTS/INT         17  32  33  34  35
TANGENT            9 7 .75 18 17 .25 -1. -1.
LOCATE/AZI         17  19  .25  00  00  00.
DUMP               1 99
AXIS               1. 0. 0. 8.
POINT/NO/NUMBER
POINTS             1
LINE               2 3
POINT/NUMBER
POINTS             6 10 11 12 13 17
ARC                3 5 4
LINE               5 8
ARC                8 9 7
POINT/NO/NUMBER
LINE               9 18
POINT/NUMBER
LINE               19 16
ARC                16 14 15
LINE               14 2
GO/TO              85
H/LABEL            2*COGO EXERCISE 1*
GO/TO              86
H/LABEL            1*ORIGIN*
```

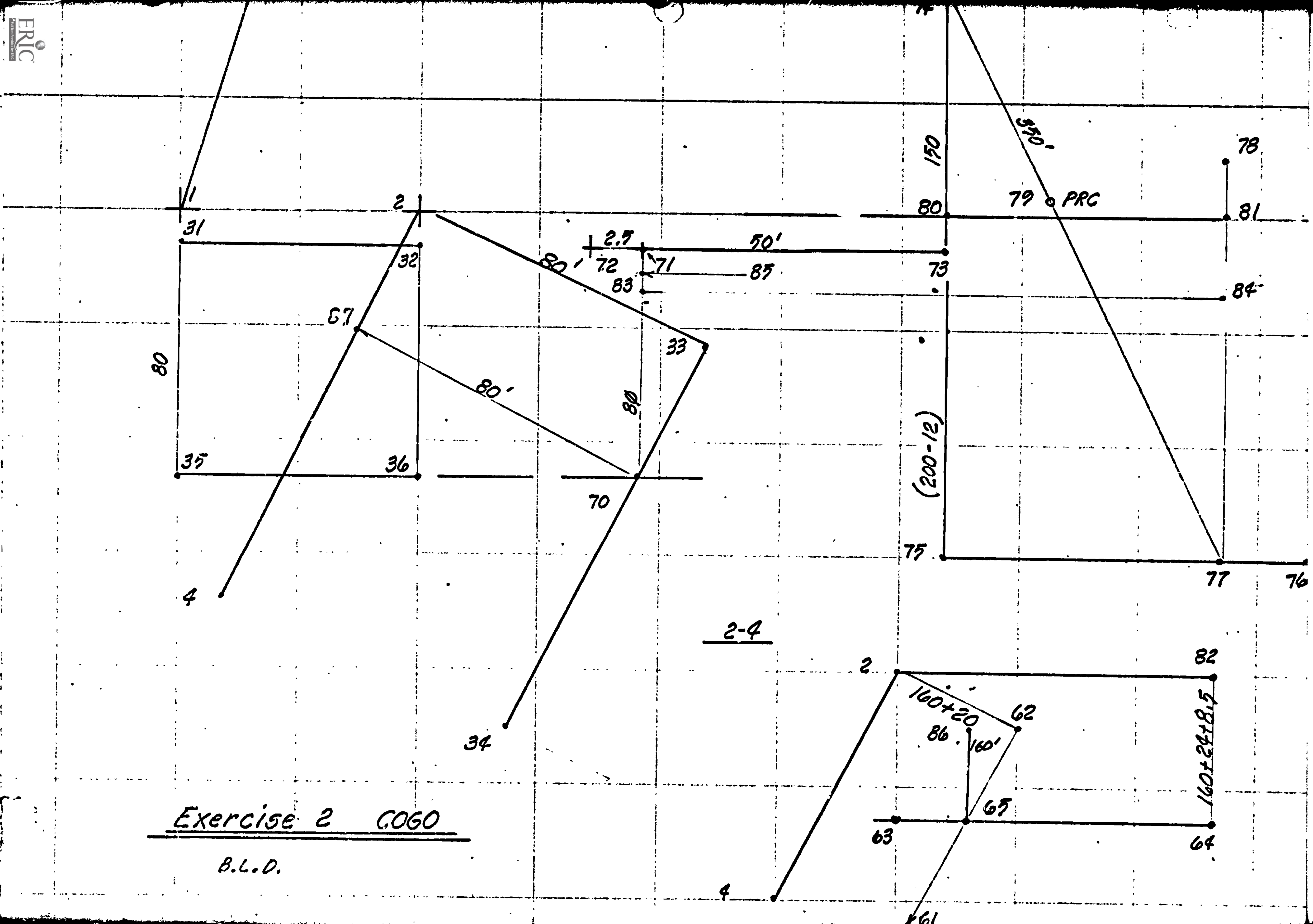


COGO EXERCISE 1

1 9 6 7 S U M M E R I N S T I T U T E
COGO EXERCISES 2 AND 3

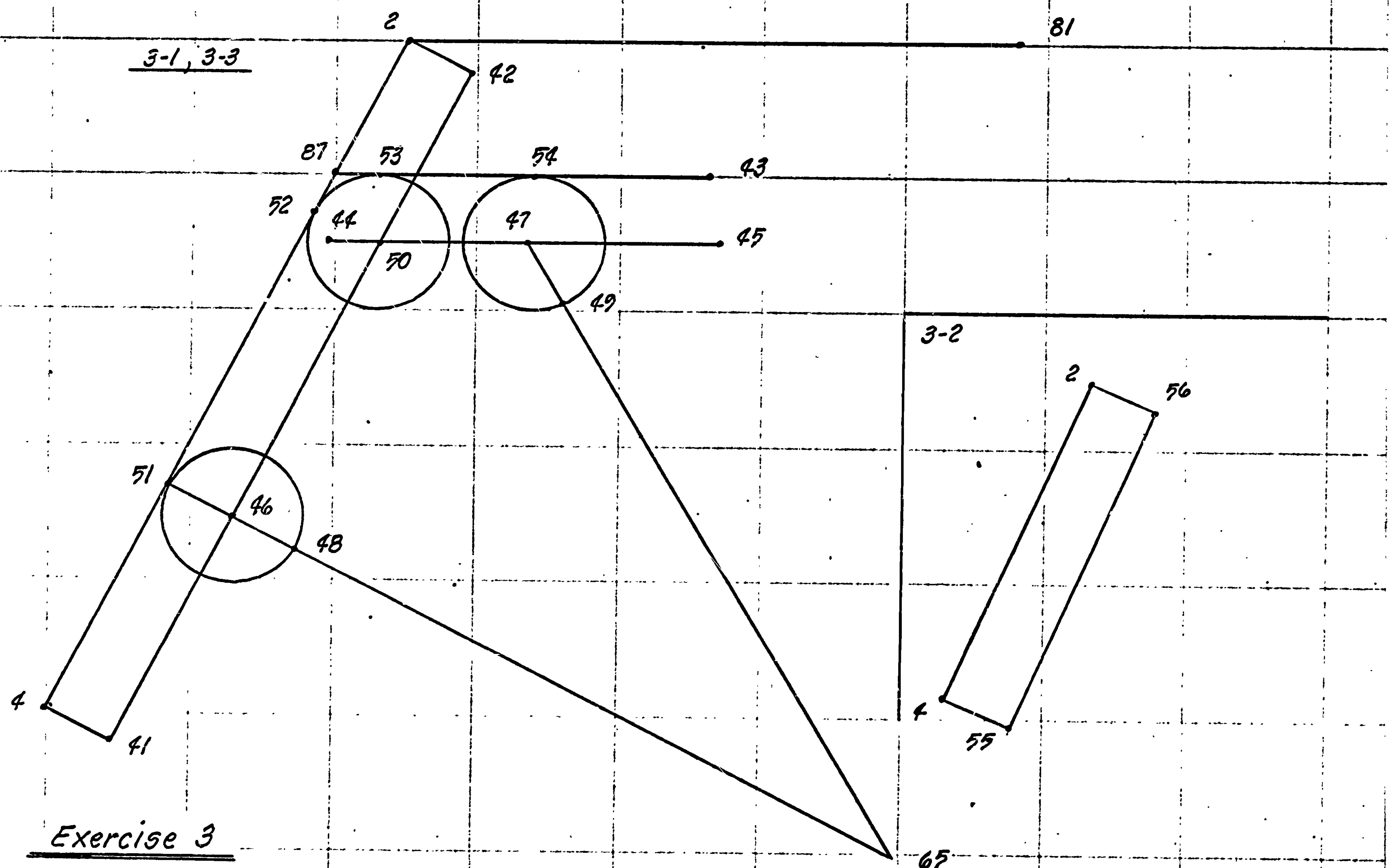
```
*         EXERCISE 2

*         SOLUTION EXERCISE 2-1

CLEAR          1 99
STORE          1 1000. 1000.
               2 1000. 1105.
LOCATE/ANG     1 2 4 200. -55 00 00.
               2 1 3 200. -65 00 00.
PARALLEL/L     1 2 3.5 31 32
               4 2 80. 34 33
               31 32 80. 35 36
POINTS/INT     70 35 36 33 34
LOCATE/AZI     70 71 80. 0 0 0.
LOCATE/LIN     71 32 72 2.5
DISTANCE       32 72

*         SOLUTION EXERCISE 2-2

LOCATE/LIN     72 71 73 52.5
LOCATE/ANG     71 73 74 150. 90 0 0.
LOCATE/LIN     74 73 75 338.
LOCATE/ANG     74 75 76 200. 90 0 0.
ARC/LINE/P     77 74 350. 75 76 76
               87 70 80. 4 2 32
LOCATE/AZI     77 78 200. 0 0 0.
ARC/ARC/IN     79 77 200. 74 150. 78
LOCATE/AZI     73 80 3.5 0 0 0.
               78 82 8.5 180 0 0.
AZ/INTERSE     81 79 180 0 0. 80 90 0 0.
LOCATE/AZI     78 84  17. 180 0 0.
               71 83 5. 180 0 0.
               71 85 2.5 180 0 0.
AREA           78 79 73 71 83 84 78
SEGMENT/PL     79 78 200.
SEGMENT/MI     79 73 150.
SEGMENT/PL     83 71 2.5

*         SOLUTION EXERCISE 2-3

PARALLEL/L     4 2 180. 61 62
               2 82 192.5 63 64
POINTS/INT     65 61 62 64 63
LOCATE/AZI     65 86 160. 0 0 0.
DISTANCE       85 2
               87 2
```

```
*          EXERCISE 3

*          SOLUTION EXERCISE 3-1

PARALLEL/L          4 2 3. 41 42
LOCATE/AZI          87 43 100. 90 0 0.
PARALLEL/L          87 43 3. 44 45
ARC/LINE/P          46 65 183. 41 42 87
                    47 65 183. 44 45 87
ARC/ARC/IN          48 46 3. 65 180. 46
                    49 47 3. 65 180. 48
POINTS/INT          50 41 42 44 45
ARC/LINE/P          51 46 3. 4 2 87
                    52 50 3. 4 2 87
                    53 50 3. 87 43 44
                    54 47 3. 87 43 45
DISTANCE            52 2
                    51 2

*          SOLUTION EXERCISE 3-2

PARALLEL/L          4 2 20. 55 56
ARC/LINE/P          57 65 160. 55 56 86
LOCATE/AZI          86 58 100. 270 0 0.
ANGLE               57 65 86
POINTS/INT          88 57 56 86 58
DISTANCE            57 88

*          SOLUTION EXERCISE 3-3

LOCATE/AZI          47 54 3. 0 0 0.
                    50 53 3. 0 0 0.
                    46 90 3. 0 0 0.
ARC/LINE/P          51 46 3. 4 2 90
                    52 50 3. 4 2 53
DISTANCE            52 2

*          SOLUTION EXERCISE 3-4

LOCATE/AZI          84 89 24. 180 0 0.
LOCATE/ANG          74 73 20 100. 90 0 0.
                    74 79 21 100. -90 0 0.
                    77 79 22 100. -90 0 0.
                    77 78 23 100. -90 0 0.
POINTS/INT          10 73 20 79 21
                    11 10 79 23 78
ALIGNMENT           700 71 10 11 73 74 79 150. 0. 850.0 50.
                    701 79 11 78 79 77 78 0. 0. -1. 0.
DUMP                1 99
```



Exercise 2 COGO

B.L.D.



Exercise 3

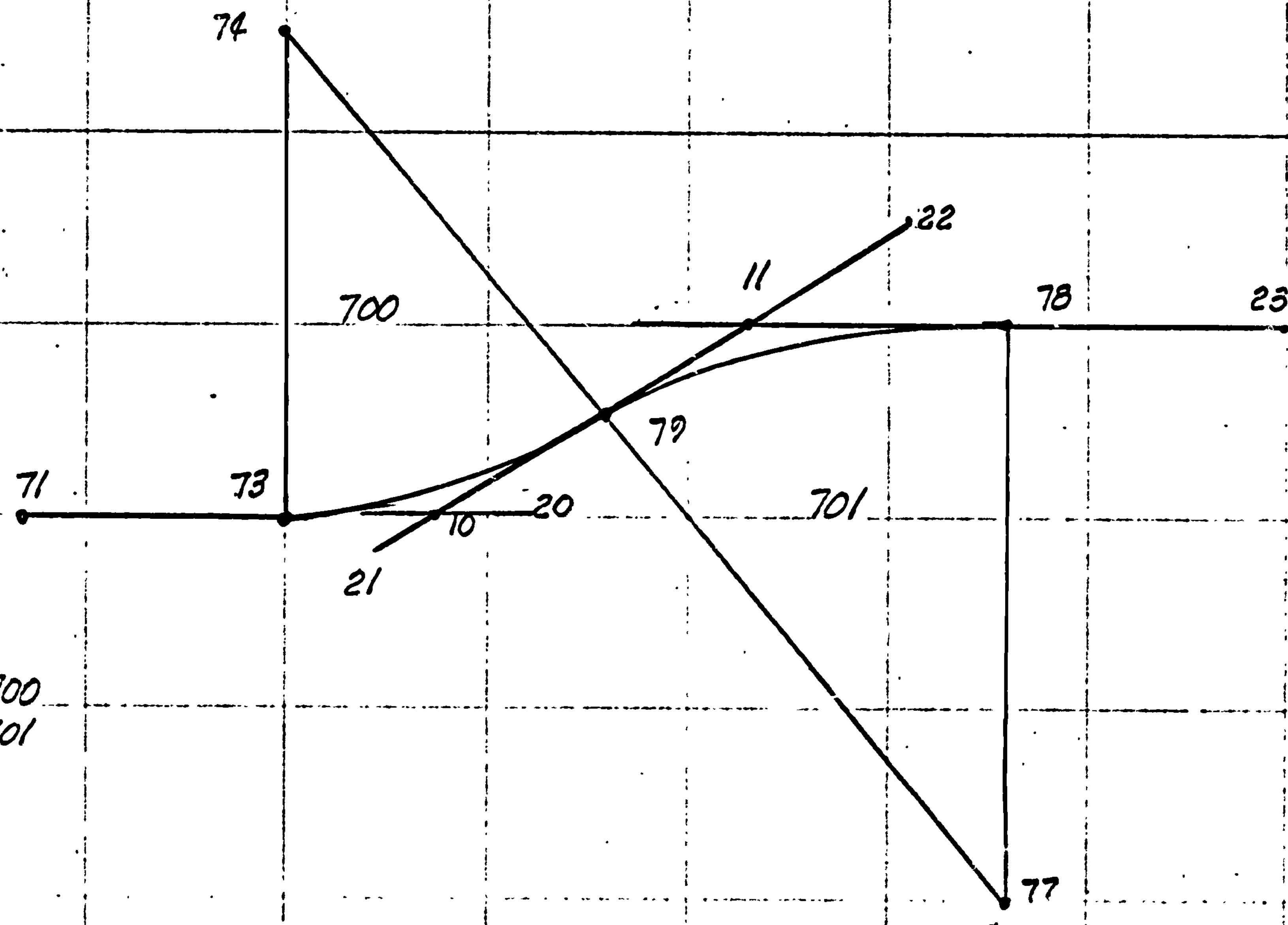
B.L.D.

3-4

B.L.O.

Find PI's

ALIGNMENT 700 701



M I A M I - D A D E J U N I O R C O L L E G E

11380 NORTHWEST 27 AVENUE

MIAMI, FLORIDA 33167

PLOTTING ROUTINES FOR COGO I-DISK

For EDP 222 - COMPUTER TECHNOLOGY APPLICATION

Department of Instrumentation and Automation

The Division of
Technical, Vocational, and Semi-professional Studies

PREFACE

The COGO plotting routines were developed by Charles L. Miller, Edward E. Newman, and John G. Skodon of the Massachusetts Institute of Technology's Civil Engineering Systems Laboratory. COGO was originally developed by M.I.T. in conjunction with the Puerto Rico Road Department.

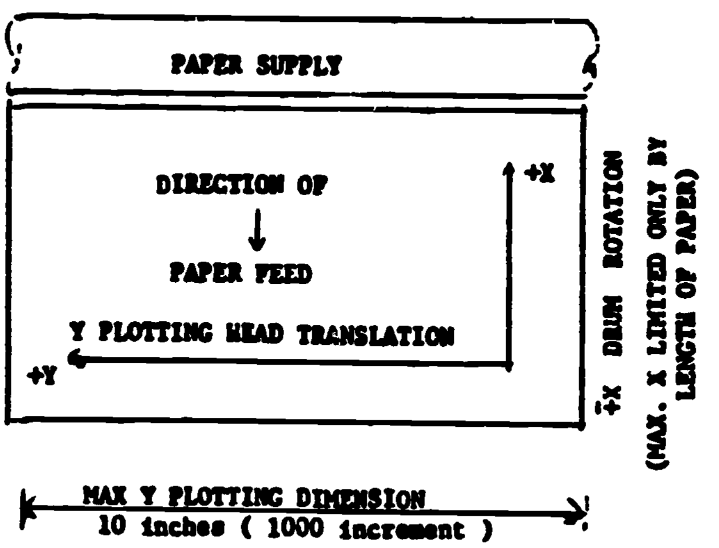
Only minor changes were necessary to adopt the routines to Miami-Dade's COGO system.

The COGO plotting routines are an extension of the COGO system. They will allow the user to display graphically on an IBM 1627 CalComp plotter the results of the coordinate computation with, or without annotation and with, or without connecting straight or circular lines.

THE IBM 1627 CALCOMP PLOTTER

The orientation convention adopted for the CalComp plotter is shown in Figure 1. The X-direction is represented by a drum rotation, thus the plotting range is limited only by the length of the paper. Normally, a full roll of paper is 120 feet long. The Y-direction is represented by a translation of the pen carriage cross-slide. Although the IBM 1627 Model 2 CalComp plotter has a physical width of 30 inches, the Y-plotting range is limited to 10 inches by the plotting routines.

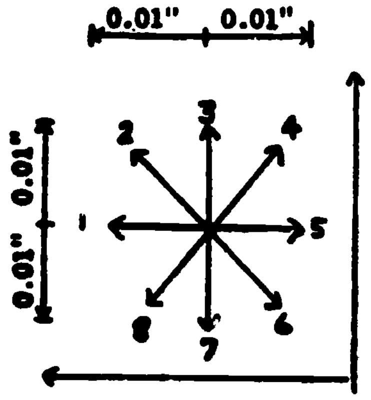
FIGURE 1



PLOTTER ORIENTATION CONVENTION
(AS VIEWED BY PERSON FACING FRONT OF PLOTTER)

The basic operation of the CalComp plotter is a movement of 0.01 inch in the ±X or ±Y direction or a combination of steps in both the X and Y direction. A graphic explanation is given in Figure 2.

FIGURE 2



INCREMENT COMMAND CODES

NUMERICAL CODE	INCREMENT COMBINATION X Y Z
0	0 0 +
1	0 + 0
2	+ + 0
3	+ 0 0
4	+ - 0
5	0 - 0
6	- - 0
7	- 0 0
8	- + 0
9	0 0 -

+Z: Lower Pen
-Z: Raise Pen

PROGRAMMING RULES

The COGO plotting routines add 9 new commands to Miami-Dade's COGO system. The following rules must be followed to prevent error messages and inaccurate drawings:

A. The input format is identical to that for other COGO commands. All command names must begin in card column 1. The data must not start before card card column 21 and cannot extend beyond card column 72. If all data will not fit on one card, it may be continued on additional cards in card columns 21-72.

B. The 9 plotting commands must be used after all other COGO commands; in other words, the graphic display of a COGO problem must follow the computations involved in its solution. If other COGO commands are used after the plotting commands, error messages will result.

C. The first plotting command must be the AXIS command.

D. The annotation commands H/LABEL, V/LABEL, and GO/TO must be used after the drawing commands AXIS, POINT, LINE, and ARC. Errors will result in the drawing if they are not used last. First, draw the problem and then put the annotation on the problem.

E. The COGO plotting routines POINT, LINE, and ARC commands initially assume that all points are to be numbered.

F. In the POINT, LINE, and ARC commands, any point which is off-scale will cause an error message to be typed on the console typewriter.

G. If the center of the circle in an ARC command is off-scale, the error message is typed but the routine continues. If either end point is off-scale, the command is ignored.

H. Points off-scale in the POINT command will cause error messages to be typed on the console typewriter until a point is found which is on-scale or until the string of points is exhausted.

I. Points off-scale in the LINE command cause the pen to be raised and remain raised until the next on-scale point is found or until the string of points is exhausted.

J. A point is off-scale when it lies to the left of the Y-axis, and/or below the X-axis. Therefore, all drawing must be done in the first quadrant of the drawn X and Y axis on the plotter paper.

COGO PLOTTING COMMANDS

1. AXIS SCALE Y X XLGTH

Explanation:

This drawing is to be plotted at a SCALE of feet per inch. The coordinates of the intersection of the vertical and horizontal axis are Y X, and the horizontal axis should be drawn XLGHT feet at the designated scale. The AXIS command automatically draws a 10-inch Y-axis. No drawing may be done to the left of the Y-axis and/or under the X-axis. Error messages will result if tried. If plotting in the negative direction is required, give Y X the value of the maximum negative coordinate that requires plotting.

Example: AXIS 200.0 5000.0 2000.0 2000.0

2. POINT I J L M . . .

Explanation:

The POINT command causes the pen to be raised, moved to the position designated by the coordinates of the point, and to draw a small cross and its associated point number. The string may consist of a single point or include the entire coordinate table. The coordinate table will handle points numbered 1-99.

Example: POINT 15 5 25 2

3. LINE I J K L . . .

Explanation:

This command causes the pen to be raised, moved to the position designated by the coordinates of the point I, and to draw a small cross and its associated point number. It then draws a straight line to the next point in succession (i.e., J) where it also draws a small cross and its associated point number. This process is repeated until the string of numbers is exhausted. The string may consist of a minimum of 2 point numbers or include the entire coordinate table.

Example: LINE 5 3 1 5

4. ARC I J K

Explanation:

This command is similar to the LINE command except that the connecting line is a circular arc having end points at I and J and its center at K. The direction of I to J <u>must</u> be counter clockwise. Only a single arc is permitted on a card. This command causes the pen to be raised and moved to the position designated by the coordinates of the center of the circle and to draw a small cross and its associated point number. The pen is then raised and moved to the position designated by the <u>first</u> of the two end points where another small cross and its associated point number are drawn. A circular arc is then drawn counter clockwise from I to J where a small cross and its associated point number are drawn. If the distance between J and K when divided by the radius as calculated by using I and K exceeds 1.0005, the error message "ERROR IN DATA" will be typed on the console typewriter.

Example: ARC 11 9 10

5. GO/TO

Explanation:

This command causes the pen to be raised and moved to the position designated by the coordinates of the numbered point. This command is used in conjunction with the H/LABEL and V/LABEL commands to position annotation.

Example: GO/TO 21

6. H/LABEL I * annotation *

This command causes the pen to commence drawing at its <u>present</u> position the characters within the asterisks. Drawing proceeds from left to right parallel to the X-axis. The normal character size is 0.10 x 0.10 inch with provision for 0.03 inch spacing. The size of the lettering may be varied by giving I different values. The normal character size is multiplied by I (i.e., SIZE = I x 0.10). The character set includes the alphabet A-Z in capitals, the numerals 0-9 and the following 8 special characters: ()-+,=/.

Example: H/LABEL 3 *JOHN H. KEITH*

7. V/LABEL I * annotation *

Explanation:

This command is identical to the H/LABEL command except that the annotation is drawn parallel to the Y-axis from bottom to top.

Example: V/LABEL 2 * SCALE = 0.20 INCH *

8. POINT/NO/NUMBER

Explanation:

The POINT, LINE, and ARC commands initially assume that all points are to be numbered. The POINT/NO/NUMBER command causes all following points to be plotted without their associated point number.

Example: POINT/NO/NUMBER

9. POINT/NUMBER

Explanation:

The numbering of points will resume when a POINT/NUMBER command is encountered.

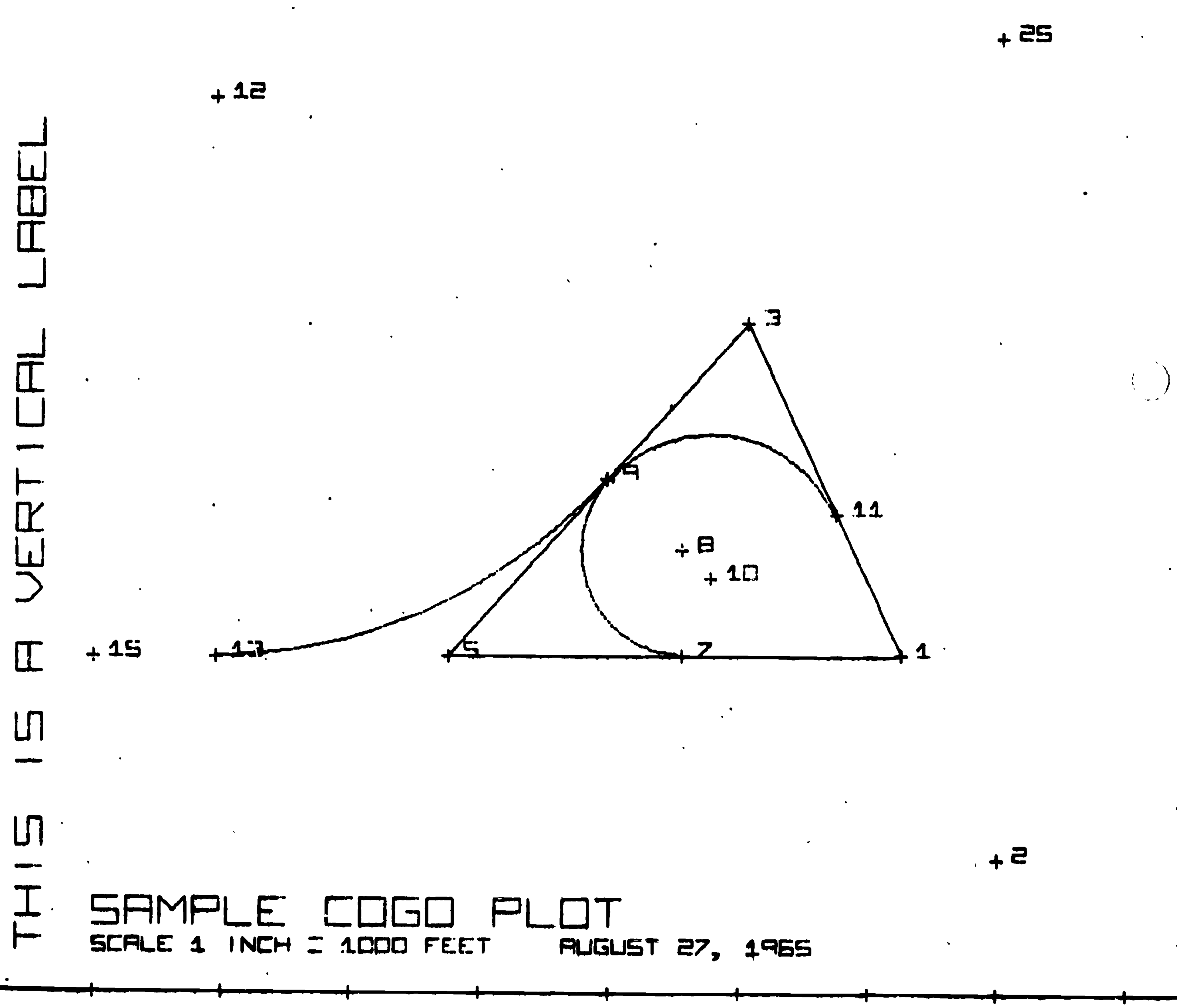
Example: POINT/NUMBER

CIVIL ENGINEERING COORDINATE GEOMETRY

ME - SAMPLE PLOTTING PROGRAM DATE - SEPTEMBER 6, 196

```
EAR                    1  99

DRE                    15  2500.0  1000.0

                       25  7100.  8000.

                       2  1000.  8000.

CATE/AZIMUTH           2  1  1695.  334 0 0.

  1          2523.4560      7256.9613

CATE/LINE              1  15  5  3500.

  5          2510.3350      3756.9859

INTS/INTERSECT         3  5  25  1  2

  3          4993.2451      6052.3653

IGNMENT                100 1  5  3  7 8 9 0. 0. 0.  1700.

100          1.0000000
83.27287     1799.9990       132            58           2.2440000
700.0000     1700.0000      1817.7547     3517.7547
  7          2517.0830      5556.9723
  9          3832.0615      4978.8842
  8          3300.3503      5554.0359

                       101 9 3 1 9 10 11 0. 0. -1. 0.

101          1.0000000
081.8185     1581.3623       111            14           51.036000
00000000     3517.7547      2100.4971     5618.2518
  9          3832.0620      4978.8848
 11          3571.9259      6745.5885
 10          3097.6882      5773.2564

                       102 9 5 15 9 12 13 0. 0. 0. 0.

102          1.0000000
136.4855     1799.9991        47             1           57.745200
```

```
0000000      .00000000     3395.5400     3395.5400
 9          3832.0615     4978.8843
13          2503.5873     1956.9994
12          6640.0434     1941.4924

RE                91  500.0  1000.0

                 92  300.0  1000.0

                 93  300.0  600.0

S                  1000.  0.  0.  10000.

NTS                15  25  2

E                  1  5  3  1

                   11  9  10

                   13  9  12

                   9  7  8

TO               91

ABEL               2 *SAMPLE COGO PLOT*

TO                92

ABEL               1 *SCALE 1 INCH = 1000 FEET    AUGUST 27, 1965*

TO               93

ABEL               2 *THIS IS A VERTICAL LABEL*
```


THIS IS A VERTICAL LABEL
+ 25
+ 12
+ 3
9
+ 11
+ 8
+ 10
+ 15
17
5
7
1
+ 2
SAMPLE COGO PLOT
SCALE 1 INCH = 1000 FEET AUGUST 27, 1965

MIAMI-DADE JUNIOR COLLEGE

11380 NORTHWEST 27 AVENUE

MIAMI, FLORIDA 33167

SPIRAL CURVE ROUTINE
FOR
COGO I - DISK

For EDP 222 - COMPUTER TECHNOLOGY APPLICATION

Department of Instrumentation and Automation

The Division of
Technical, Vocational, and Semi-professional Studies

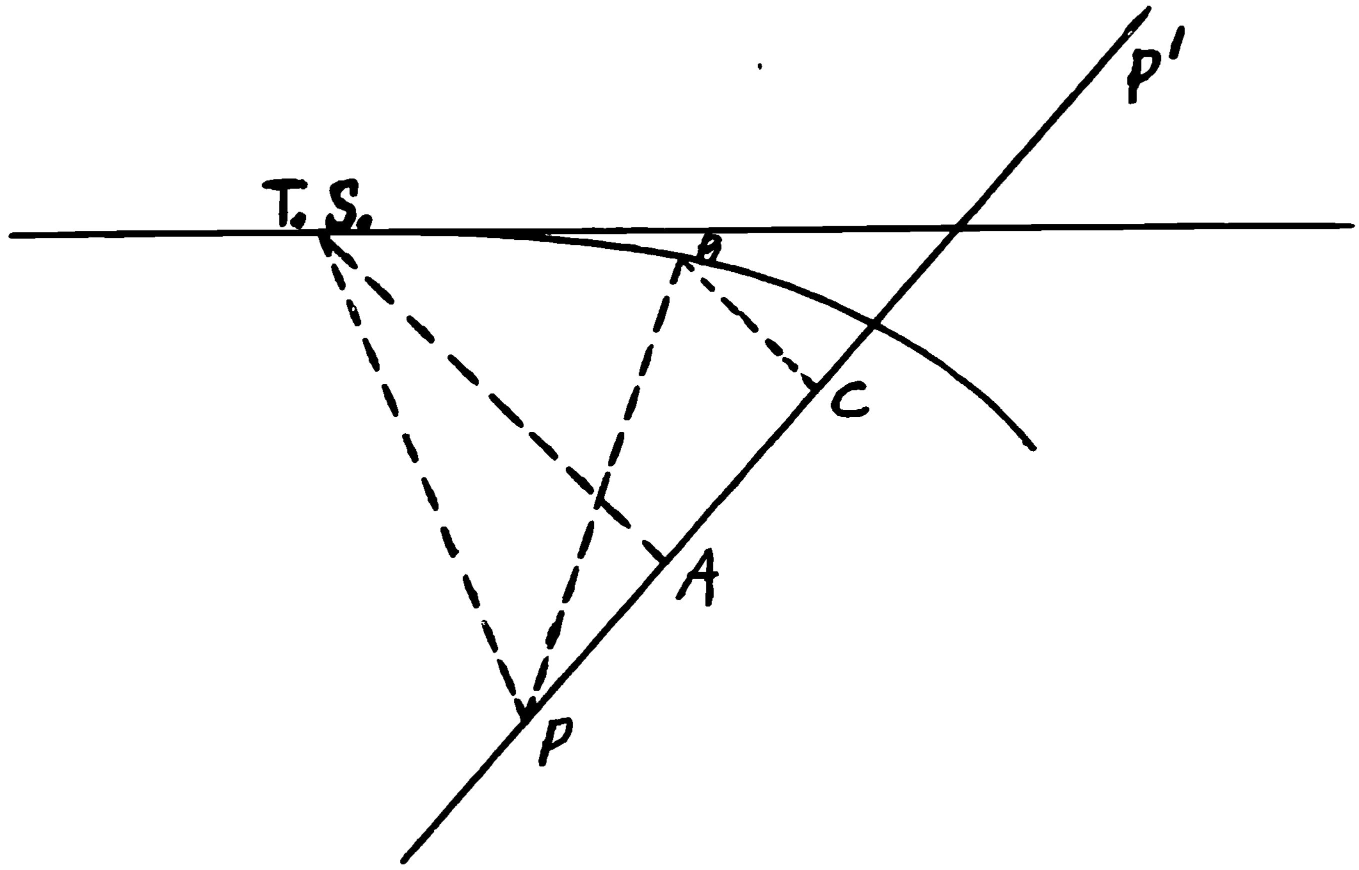
PREFACE

The spiral curve routine will permit the civil engineer to compute the coordinates of a point at a given length along a spiral, intersect a straight line with a spiral, and intersect a circular curve with a spiral.

The spiral curve routine was developed by Paul R. Schopfer in conjunction with Chas. H. Sells, Inc., Civil Engineers and Surveyors, 409 Manville Road, Pleasantville, New York 10570. Because the routines was originally written for the COGO card system, a few minor modifications were made so that the routine could be incorporated into the Miami-Dade Junior College's COGO-Disk system.

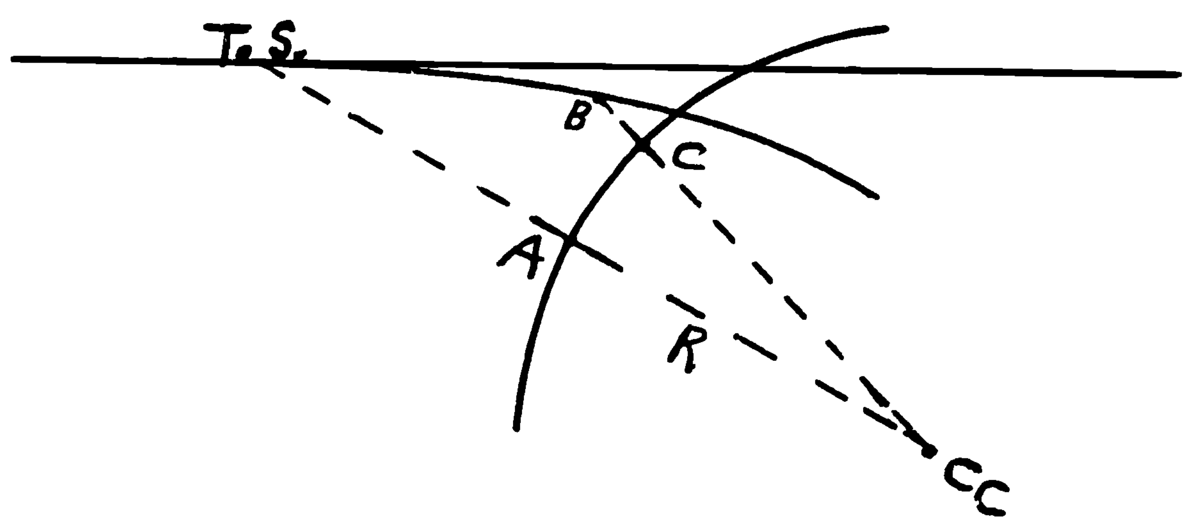
The intersections are computed by the following two methods:

1. SPIRAL-LINE INTERSECTION



A connection is made from point P on the straight line (see above figure) to the T.S. of the spiral. The angle T.S.-P-P' is computed from which the absolute value of T.S.-A is found. This is the first trial spiral length to point B. Distance B-C is then computed by the same method. If distance B-C is not within the allowable tolerance which the program sets at .001 ft., the absolute value of B-C is added to the trial spiral length and a new point is computed. This procedure continues until the set tolerance is reached and the solution is obtained.

2. SPIRAL-ARC INTERSECTION



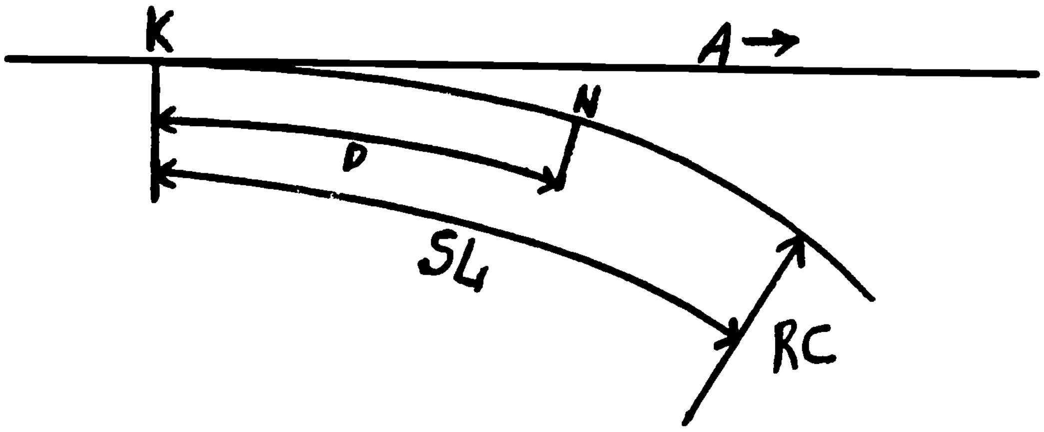
A connection is made from the T.S. (see above figure) to the center of the circular curve, i.e., distance T.S.-CC. The absolute value of the difference between T.S.-CC and the radius of the circular curve is assumed as the first trial spiral length to point B. Distance B-CC is computed and compared with the radius R. If they do not compare within the allowable limit (.001 ft.), the absolute value of this difference is added to the spiral length and a new point is computed. As in the line intersection, the procedure continues until the tolerance is reached and the solution is obtained.

Notes:

This routine adds four new operation commands to the COGO I-DISK programming language. When these commands are used, all rules and input/output specifications given in the COGO I-DISK programmer's manual and this pamphlet, <u>must</u> be followed.

If the line or arc intersection routines are used and no output is obtained, the line or arc does not intersect the defined spiral and the point stored in the coordinate table for the intersection will be the S.C. Since intersections are performed by a trial and error type solution, it is not uncommon for individual problems to take up to five minutes to solve depending upon the strength of the intersection.

1. SPIRAL/COORDINATES N D K A SL RC SIGN



Locate point N at a distance D along the spiral whose T.S. is at K, having a forward tangent azimuth of A and a spiral length of SL to a circular curve of radius RC. Sign is +1. if the spiral curves to the right and -1. if it curves to the left.

Output:

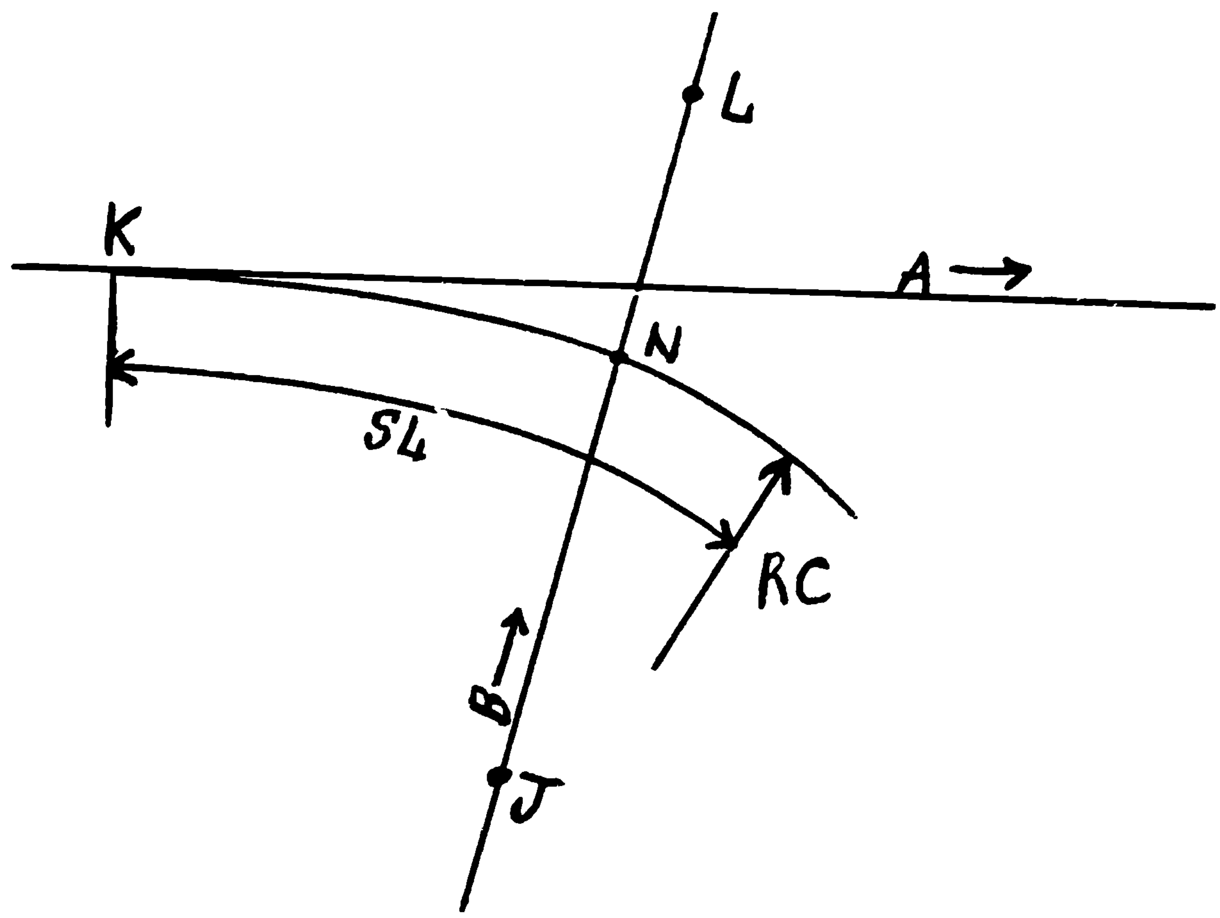
Coordinates of N

Spiral length K to N, Spiral angle to N

Example:

SPIRAL/COORDINATES 7 132.35 9 35 42 20. 250. 2000. +1.

2. SPIRAL/POINTS/INT N J L K A SL RC SIGN



Locate point N as the intersection of the line defined by points J and L with the spiral whose T.S. is at K, having a forward tangent azimuth of A and a spiral length of SL to a circular curve of radius RC. Sign is +1. if the spiral curves to the right and -1. if it curves to the left. If there is more than one point of intersection, the one closest to the T.S. is computed.

Output:

Coordinates of N

Distance and azimuth of J to N

Spiral length K to N, Spiral angle to N

Example:

SPIRAL/POINTS/INT 7 12 9 4 182 28 10. 200. 1500. -1.

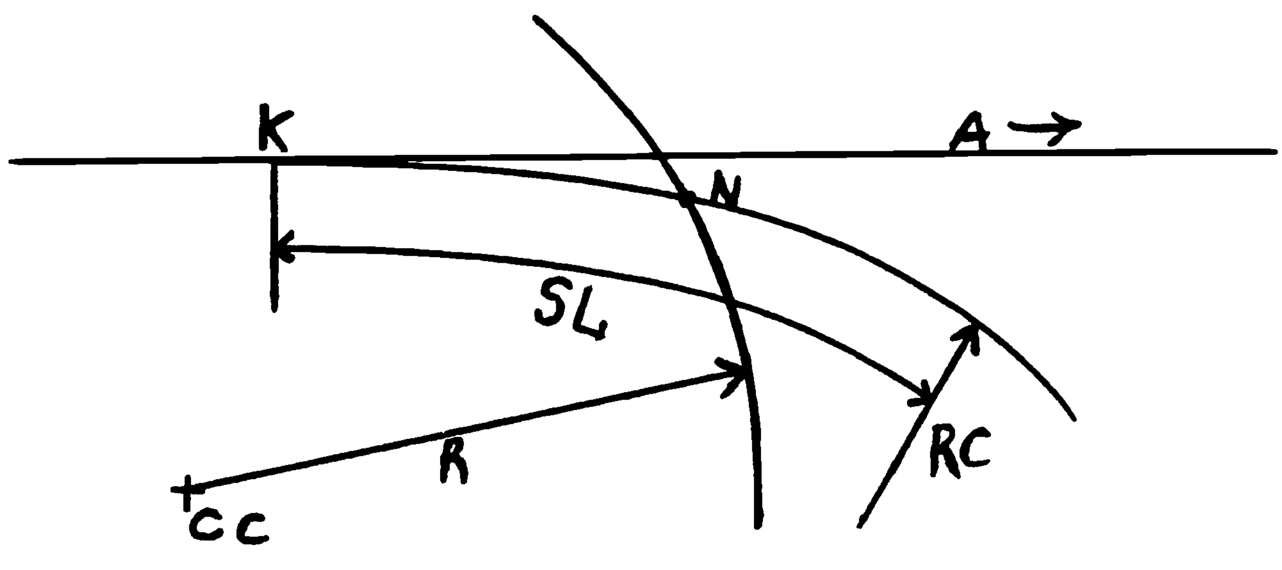
3. SPIRAL/AZ/INT N J B K A SL RC SIGN

Same as spiral/points/int except the line is defined by point J and azimuth B.

Example:

SPIRAL/AZ/INT 7 10 35 48 30. 3 225 4 50. 250. 2000. +1

4. SPIRAL/ARC/INT N CC R K A SL RC SIGN



Locate point N as the intersection of the circular curve having a center of CC and a radius of R with the spiral whose T.S. is at K, having a forward tangent azimuth of A and a spiral length of SL to a circular curve of radius RC. Sign is +1. if the spiral curves to the right and -1. if it curves to the left. If there is more than one point of intersection, the one closest to the T.S. will be computed.

Output:

Coordinates of N

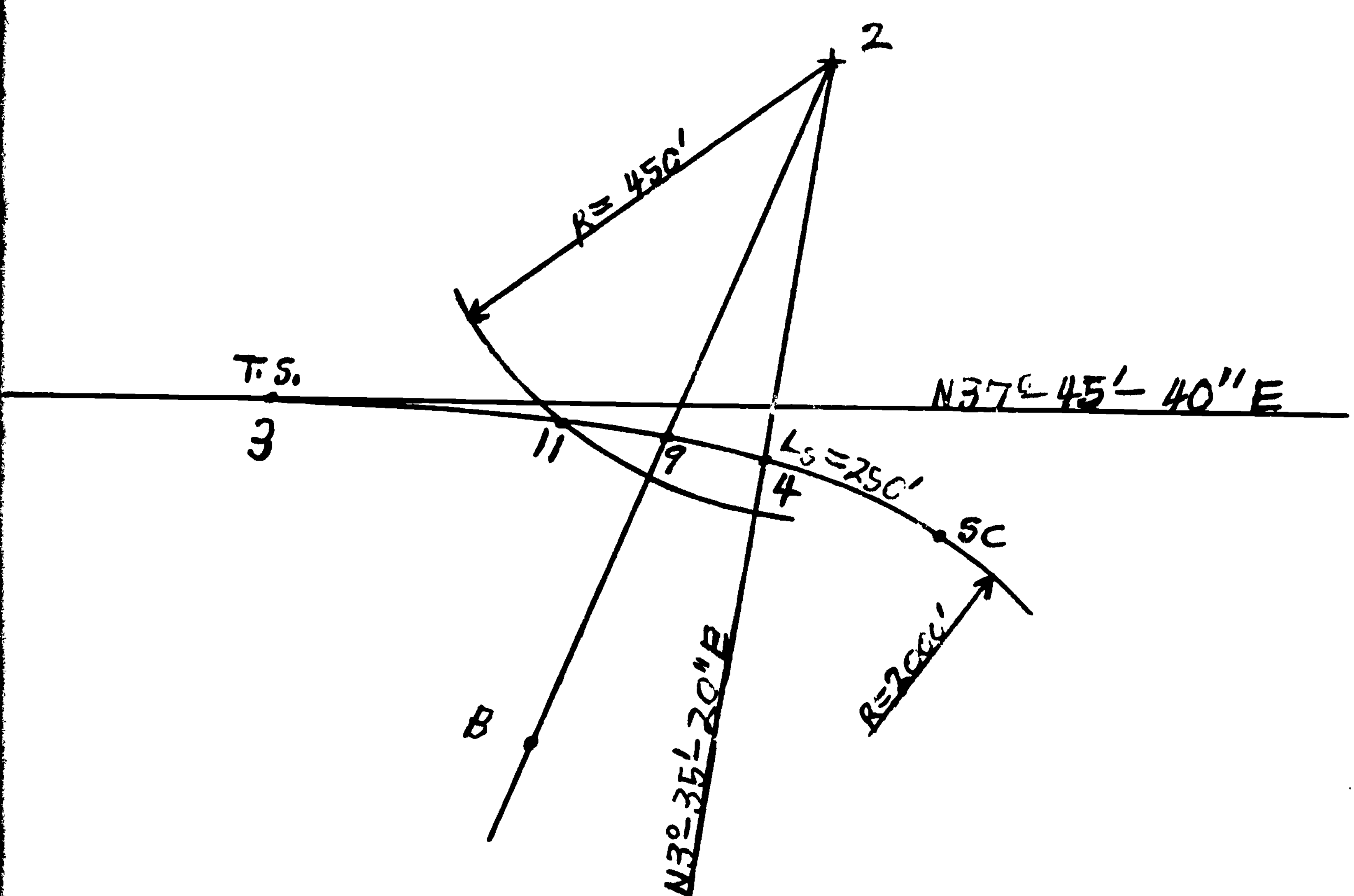
Distance and Azimuth of CC to N

Spiral length K to N, Spiral angle to N

Example:

SPIRAL/ARC/INT 4 6 600. 8 20 24 40. 150. 1000. +1.

SAMPLE PROBLEM



CIVIL ENGINEERING COORDINATE GEOMETRY

E - SAMPLE PROBLEM DATE - JULY 25, 1966

SAMPLE PROBLEM SPIRAL PLUG DECK

AR 1 99

RE 1 7905. 1500.

2 8500. 1405.

3 7906. 1262.

8 7950. 1360.

RAL/COORDINATES 14 184.250 3 37 45 40. 250. 2000. 1.

14	8050.3692	1376.4643			
3	14	184.25000	1	56	42.290520

RAL/AZ/INT 4 2 183 35 20. 3 37 45 40. 250. 2000. 1.

4	8050.8047	1376.8261			
2	4	450.07781	183	35	20.148000
3	4	184.81604	1	57	25.380360

RAL/POINTS/INT 9 2 8 3 37 45 40. 250. 2000. 1.

9	8039.2796	1367.3039			
2	9	462.25976	184	40	39.036000
3	9	169.86618	1	39	11.671560

RAL/ARC/INT 11 2 450. 3 37 45 40. 250. 2000. 1.

11	8050.8780	1376.8869			
2	11	450.00085	183	34	54.444000
3	11	184.91137	1	57	32.650560

M I A M I - D A D E J U N I O R C O L L E G E

11380 NORTHWEST 27 AVENUE

MIAMI, FLORIDA 33167

PARABOLIC CURVE ROUTINE
FOR
COGO I - DISK

For EDP 222 - COMPUTER TECHNOLOGY APPLICATION

Department of Instrumentation and Automation

The Division of
Technical, Vocational, and Semi-professional Studies

PREFACE

This subroutine permits the solution of parabolic curves. The addition of this subroutine to COGO I-DISK will allow the highway engineer to solve both horizontal and vertical alignment problems with the COGO I-DISK program.

The vertical curve routine was developed by C. W. Glennon, an IBM employee, in conjunction with Mead & Hunt Incorporated, Madison, Wisconsin, for use with COGO I. Because Miami-Dade Junior College's COGO System is the disk version of COGO instead of the card version, modifications were made to the subroutine so that it would work on our system.

The subroutine utilizes standard formulae to solve for elevations at all curve stations, the elevation at any given point, and the low point on the curve.

Following is a list of these formulae:

1. Grade Back (GB) = $(ELEV_{PI} - ELEV_{BT}) / (STA_{PI} - STA_{BT})$
2. Grade Fwd (GF) = $(ELEV_{FT} - ELEV_{PI}) / (STA_{FT} - STA_{PI})$
3. Curve Const (A) = $(GB - GF) / VCL \times 50$
4. Station Elev = $ELEV_{PC} + (GB - A \times DIST) \times DIST$
5. Low Station = $STA_{PC} + ((ELEV_{PT} - ELEV_{PC}) \times GB / (GB-GF))$

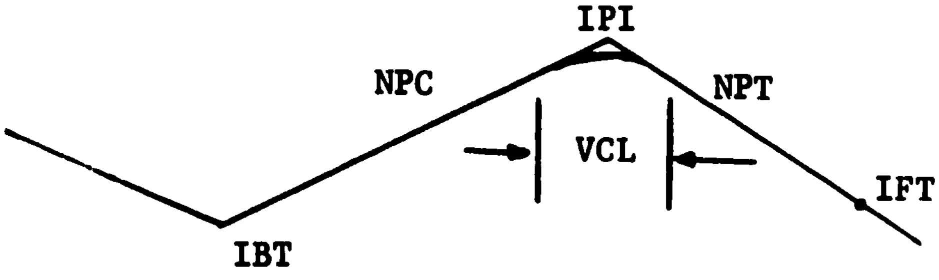
Following abbreviations are used in the above formulae:

BT - Point on back tangent
FT - Point on forward tangent
PC - Point of curve
PI - Point of Intersection
PT - Point of tangent
DIST - Distance from PC in stations
VCL - Vertical curve length

This subroutine adds four new operation commands to the COGO I-DISK programming language. When these commands are used, all rules and input/output specifications given in the COGO I-DISK programmer's manual and this pamphlet, must be followed.

INPUT/OUTPUT SPECIFICATIONS

1. VERH/CURVE IBT IPI IFT NPC NPT VCL



Compute the vertical curve, given the following:

IBT	-	Number of any point on back tangent
IPI	-	Number of PI
IFT	-	Number of any point on forward tangent
NPC	-	Number assigned to PC
NPT	-	Number assigned to PT
VCL	-	Length vertical curve in feet

<u>NOTE:</u> IBT, IPI & IFT must be located with "Store" or other commands.

<u>OUTPUT LIST</u>

Station of PC, Elevation of PC
Station of PI, Elevation of PI (on curve)
Station of PT, Elevation of PT, external (- if cut, + if fill)

2. CURVE/DATA NPC IPI NPT STINC

Compute station and elevation data for the curve, given the following:

NPC	-	Number of PC
IPI	-	Number of PI
NPT	-	Number of PT
STINC	-	Station Increment Desired

<u>OUTPUT LIST</u>

Station, elevation (of all points, the station increment apart, for the entire curve)

INPUT/OUTPUT SPECIFICATIONS - (continued)

3. CURVE/POINT NPC IPI NPT STA

Compute Elevation of station noted:

OUTPUT LIST

Station, elevation

4. CURVE/DRAIN NPC IPI NPT

Compute station and elevation of lowest (or highest) point on curve

OUTPUT LIST

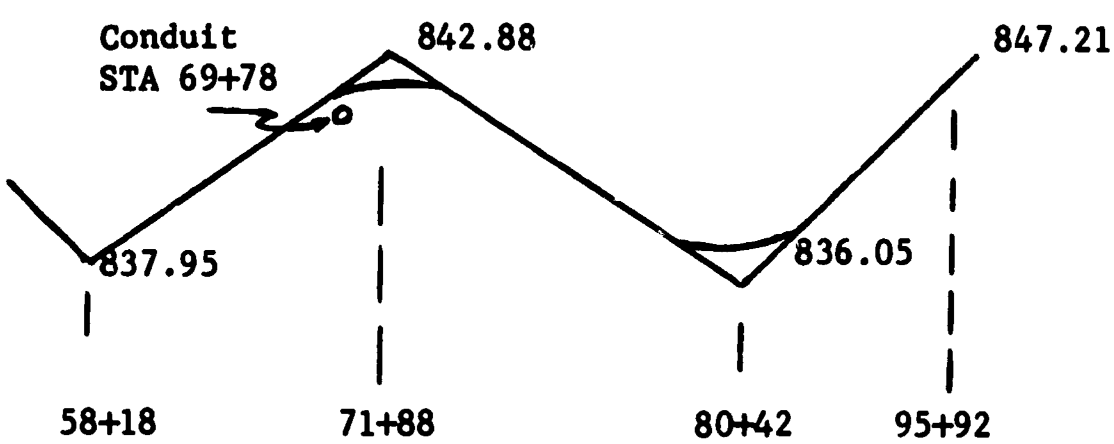
Station, elevation

SAMPLE PROBLEM

The vertical curve at station 71 + 88 (Fig. 2) is solved for both an 800 foot and a 1000 foot curve.

It is then desired to know the elevations at 100 foot stations around the curve. The command "CURVE/POINT" is used to determine the curve elevation above the conduit at Station 69 + 78.

A second vertical curve at station 80 + 42 is computed. This time however elevations are needed every 50 feet. The station and elevation of the low point are determined using the CURVE/DRAIN command.



```
*              SAMPLE PROBLEM FOR VERTICAL CURVE DECK
*
CLEAR          1   99
*
*                STATION   ELEVATION
*
STORE          1   58.18      837.95
               2   71.88      842.88
               3   80.42      836.05
               4   95.92      847.21
*
VERH/CURVE       1  2  3  11  12  800.
 67.880000  841.44059
 71.880000  841.72038
 75.880000  839.68094    -1.1596200
*
VERH/CURVE       1  2  3  13  14 1000.
 66.880000  841.08073
 71.880000  841.43047
 76.880000  838.88118    -1.4495300
*
CURVE/DATA       11  2  12  100.
 67.880000  841.44059
 68.000000  841.48293
 69.000000  841.77089
 70.000000  841.94289
 71.000000  841.99892
 72.000000  841.93899
 73.000000  841.76310
 74.000000  841.47125
 75.000000  841.06344
 75.880000  839.68094
*
CURVE/POINT      11  2  12  69.78
 69.780000  841.91500
*
VERH/CURVE       2  3  4  21  22  700.
 76.920000  838.84918
 80.420000  837.37980
 83.920000  838.57000     1.3298000
*
CURVE/DATA     21   3  22  50.
 76.920000  838.84918
 77.000000  838.78590
 77.500000  838.42184
 78.000000  838.11206
 78.500000  837.85655
 79.000000  837.65532
 79.500000  837.50837
 80.000000  837.41570
 80.500000  837.37730
 81.000000  837.39319
 81.500000  837.46334
```

SAMPLE PROBLEM FOR VERTICAL CURVE DECK - (continued)

```
 82.000000  837.58778
 82.500000  837.76649
 83.000000  837.99949
 83.500000  838.28675
 83.920000  838.57000
*
CURVE/DRAIN        21   3   22
 80.603699  837.37614
PAUSE
```

1967 SUMMER INSTITUTE
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IBM 1627 PLOTTER A26-5710-0

IBM 1620-1627 FORTRAN PLOTTER SUBROUTINES C26-5841-1

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MILGO X-Y RECORDERS SERIES 4000

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MILGO CAPABILITIES AND FACILITIES

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